POWER

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ELY C. HUTCHINSON, *Editor*

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EDITORIALS

Gasoline Injection for Engine Fuel

Cogent interest in fuel injection and supercharging, to supersede carburetion for gasoline engines, is in the air. It is strange but true that until recently orthodox thinking has completely dominated fuel-mixture ideas in engines of this type. Latterly however, engineers and designers are displaying a commendable curiosity as to the possibility of applying the experience of fuel-oil injection to gasoline fuel.

Withal, it must not be forgotten that the successful system will require further development in gasoline pump design as well.

Propeller Hydro Units for Higher Heads

A recent announcement that a propeller-type turbine with adjustable blades is being built for a head of over 100 ft. is another reminder that one who promulgates engineering limitations is likely to be proven a false prophet.

Ten years ago 30 ft. was thought by some to be about the upper limit of heads at which a propeller-type wheel could be operated. Engineers, however, soon proved the fallacy of this limit by designing wheels for double that head and also of unprecedented size.

Last year, even this record was broken with the construction of three 10,000-hp. Kaplan-type runners for 76-ft. head. Now the laurels go to a Kaplan turbine to be intalled for a maximum head of over 100 ft.

The high speed at which this type runner operates, its high efficiency over a wide range of load and ability to operate under varying heads makes it a desirable type in many places. As its design principles are better understood it will undoubtedly still further invade the field of the Francis-type wheel, just as the latter has been applied to heads that a few years ago were considered adapted only to the Pelton-type.

Power Signs

- **BEFORE the depression, a lot of people were too busy taking orders to worry much about how the cost of their product could be lowered.**
- **THINGS are different now. The cloud of reduced immediate business demand has been turned inside out and a silver lining of renewed interest in the cost of isolated power, as affecting lower production cost, is strongly evident.**
- **THIS interest is commercial, as shown by the desire of owners to reduce costs, and technical, as shown by builders' new designs and improvement of power producing machinery.**
- **NOW also, comes a growing number of high-class technicians who are teaching the isolated plant owners how to operate more efficiently with what they have and to secure maximum results at minimum expense.**
- **THERE is plenty of room for all these activities and encouragement for cheaper power in their prosecution.**

Conditioned Air As A Factory Tool

As in many another so-called new idea, some of the advantages of conditioned air have been slow of adoption. It seems to take just so long for humans to overcome their resistance to change, benefits notwithstanding.

Where proper atmospheric conditions are essential to the success of a manufacturing process, the idea is now generally accepted as something it is impossible to do without. The silk and tobacco industries are examples of this. Theaters, auditoriums and some other public buildings are coming more to appreciate the greater promise of a full house where coolness and comfort are available.

But the idea that proper atmospheric conditions for the worker in office and factory is a paying investment for employers has, until very recently, been conspicuously absent.

A cigar factory, by giving conditioned air to the working force, reduced absences among women from fifty half-days to five. Rejections of product for imperfections dropped from three to one per cent.

Certainly, in this single instance, there is enough to make interested persons seek the secret of this comparatively new factory tool.

AN APPEAL TO SELF INTEREST

• This is the time for all good citizens to aid the rehabilitation of industry and reemployment of men. Commodity markets, which absorb goods by direct consumption, are well on the upward path, and practically all other indicators of national health are favorable to economic recovery, except the market for capital goods. Capital goods are those purchased on capital account, for industrial use, in the production of other things. Jobs for more than one and a half millions of workers are in the balance in the machinery industries alone.

• Power production machinery is one of the most important in the capital goods class, because of the basic need for power services. Modernization and better operation of existing power plants are essential to lower manufacturing costs.

• If for no other reason than to benefit personally from better times, there is a unity of interest among power machinery manufacturers, industrial executives and consulting engineers that urges the closest cooperation between them.

• Despite this, the reluctant third of this group is the industrial executives, who seemingly incline to hibernation until the signs of spring are satisfactory to them.

• It is the work of the Robertson Committee on Industrial Rehabilitation to help these people out of their holes by appealing to their own self interest. Sub committees are being formed in each of the Federal Reserve districts. These subcommittees will, in turn, appoint local business and industrial leaders to their membership, for the purpose of contacting important industrial executives. It will be the duty of these men to secure the release of orders for capital equipment wherever sound economy warrants.

• A list is given of the chairmen and vice-chairmen for all districts. Manufacturers and consulting engineers are urged to confer with these men to learn how to be of assistance and of greater use to themselves as well as to those dependent upon them for employment.

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Local newspapers and other publicity is planned in each district to keep people informed of the activities and development of industrial rehabilitation plans.

NEW BOILER SPINS AT TURBINE SPEED

By DR. ING. HEINRICH VORKAUF

Berlin, Germany

First American description of a sensational German development, published by *Power* simultaneously with the *V. D. I. Zeitschrift* of Berlin. Tubes of high-pressure boiler, turning with turbine shaft, eliminate feed pumps and draft fans. Except for switching and fuel handling, the entire steam plant becomes a single machine

▼

MODERN boiler construction is distinguished by the development of the steam generator into a machine. In the following a machine is described which not only makes possible the complete mechanization of the steam generator but also the consolidation of the component parts of the entire steam power plant into a single compact unit. The basis for this is a new method of operating the boiler, in which the heating surfaces are rotated at high speeds. The utilization of the resulting centrifugal forces in the water, and the gas turbulence attained by rapid motion of the heating surfaces, are a radical departure from accepted practice in constructing steam power plants.

This article, published simultaneously by the *V.D.I. Zeitschrift* in Germany and *Power* in America, was made available by the German company which developed this new type of power plant—the "Gesellschaft für La Mont-Kessel und Kraftwirtschaft m.b.H."

Centrifugal Force in Boiler Replaces Feed Pump

Correct utilization of centrifugal forces in the rotating boiler makes it possible to supply feed water against high steam pressure without the use of a feed pump.

The principle of operation is shown, diagrammatically, in Fig. 1. If one leg *b* of the rotating U-shaped tube system is heated it will contain a steam-water mixture much lighter than the solid water column in tube *a*. Centrifugal action (depending on diameter, speed and the difference in densities) builds up a definite pressure in tube *b*.

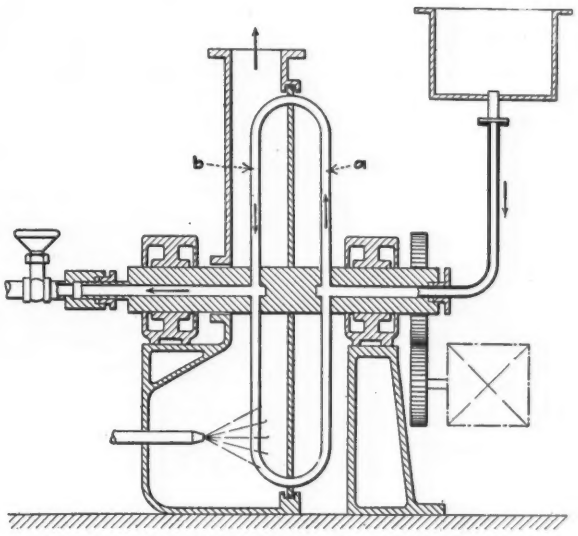


Fig. 1—How it works (for actual construction see Figs. 6 and 7)

Centrifugal action of water in *a* overbalances that of steam in *b* by an amount equivalent to the steam pressure, which may be a thousand pounds or more at commercial speeds

This pressure-building effect was investigated on a simple experimental model sketched in Figs. 2 and 3. It consists of a return-bend tube system arranged so that it can be rotated. Water is led into the hollow shaft at *c* and is thrown outward into the tubes *a* insulated to prevent the formation of steam within. In the other leg *b*—or more precisely, in the four parallel legs—steam is generated. This is led off from the hollow shaft through a stuffing box *d*.

The whole rotating tube system is heated by a gas burner *f*, the heating gases being drawn through the casing by the fan action of the rotating tubes and discharged through the flue *g*. The rotating-tube system is driven by an electric motor. Fig. 4 shows a view of the complete experimental plant with the overhead water tank feeding water to the model through a rubber hose.

From the diameter of the pipe system of the experimental model (28.6 in.) and an assumed difference of the densities in the water supply and steam generating pipes of 62.4 lb. per cu.ft., the increase of pressure at different speeds can be calculated. This pressure increase is plotted against r.p.m. in Fig. 5. The tests on the model check this curve, as the recorded test values show. With the simple experimental model steam pressures up to 425 lb. absolute were obtained at 2,200 r.p.m.

Use of this process for the steam generator therefore shows the possibility of providing for the pressure increase without a feed pump. Moreover, no external driving force is necessary to circulate the water at the

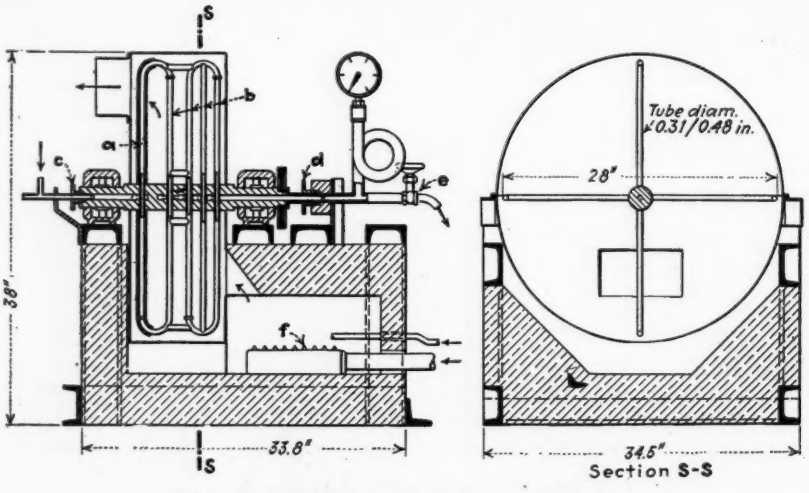


Fig. 2 (left)—Experimental model, longitudinal section, Fig. 3—Section S-S of Fig. 2

a Water-supply tubes, *b* Steam generating tubes, *c* Stuffing box for feed water, *d* Stuffing box for steam discharge, *e* Shut-off valve, *f* Gas burner, *g* Outlet for heating gases

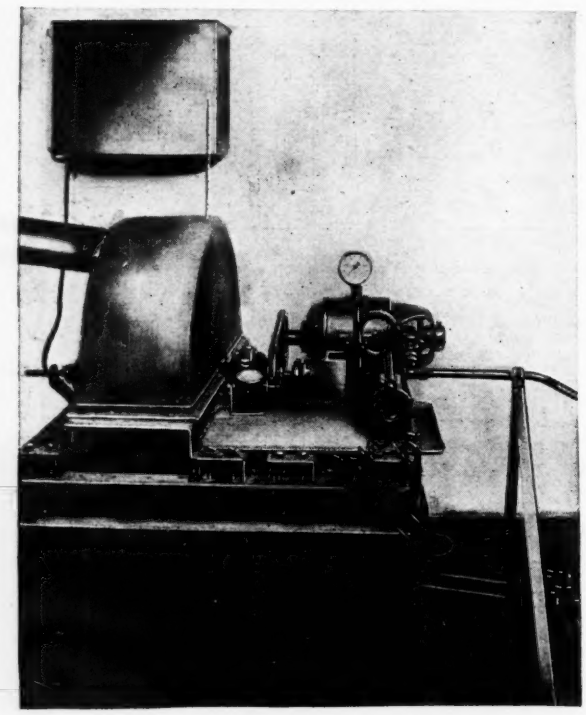


Fig. 4—View of the experimental plant

Water supply from the reservoir on left at top. Pressure indicated at the steam side of the model on the gage at right

desired pressure. Movement of the water results from the transformation of the water into steam, and the work necessary for this finds its equivalent in the formation of steam of higher pressure at the outer circumference of the rotating pipe system and in the expansion of this steam as it moves back toward the middle of the shaft.

Boiler and Turbine Assembled as a Single Rotor

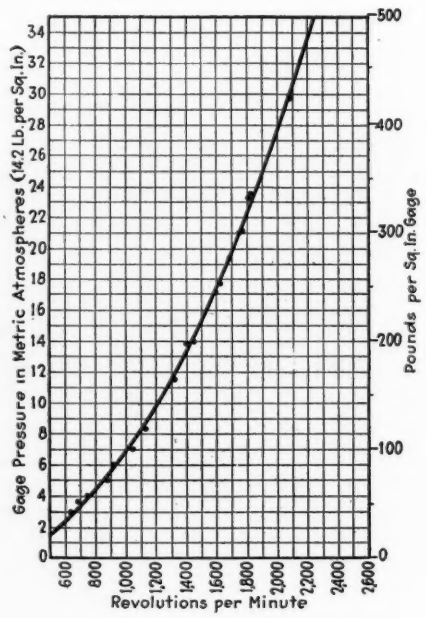
If steam ready for use (evaporated and superheated) is produced in the rotating steam generator, the steam generator and the steam turbine can be built up as a single rotor.

Fig. 6 and 7 show the design ot such a unit. The water is led into the hollow shaft (Fig. 6) on the right at *n* and flows through it into the preheater ("economizer") tubes *a*. In these tubes the water is thrown outward and thereby placed under pressure. It then passes through the tubes *b*, arranged on the periphery, to the spoke-like tubes *c*. Steam is generated in the tubes *b* and *c*, whereby there results a difference of the centrifugal action of the water in the tubes *a* and the steam-water mixtures in the tubes *c*. The resulting increase in pressure, assuming a definite water content in the tubes *c* and a speed of 3,000 r.p.m. of the unit with 44.5-in. system diameter to the centers of the peripheral tubes (external peripheral velocity 580 ft. per sec.) causes a maximum absolute pressure of the steam in the steam collector space *d* of 1,700 lb.

Steam at 1,700 lb. flows through superheater *e* and an insulated collector tube *f*, in the left end of the hollow shaft, to the revolving nozzles of an auxiliary turbine. There the steam expands to the

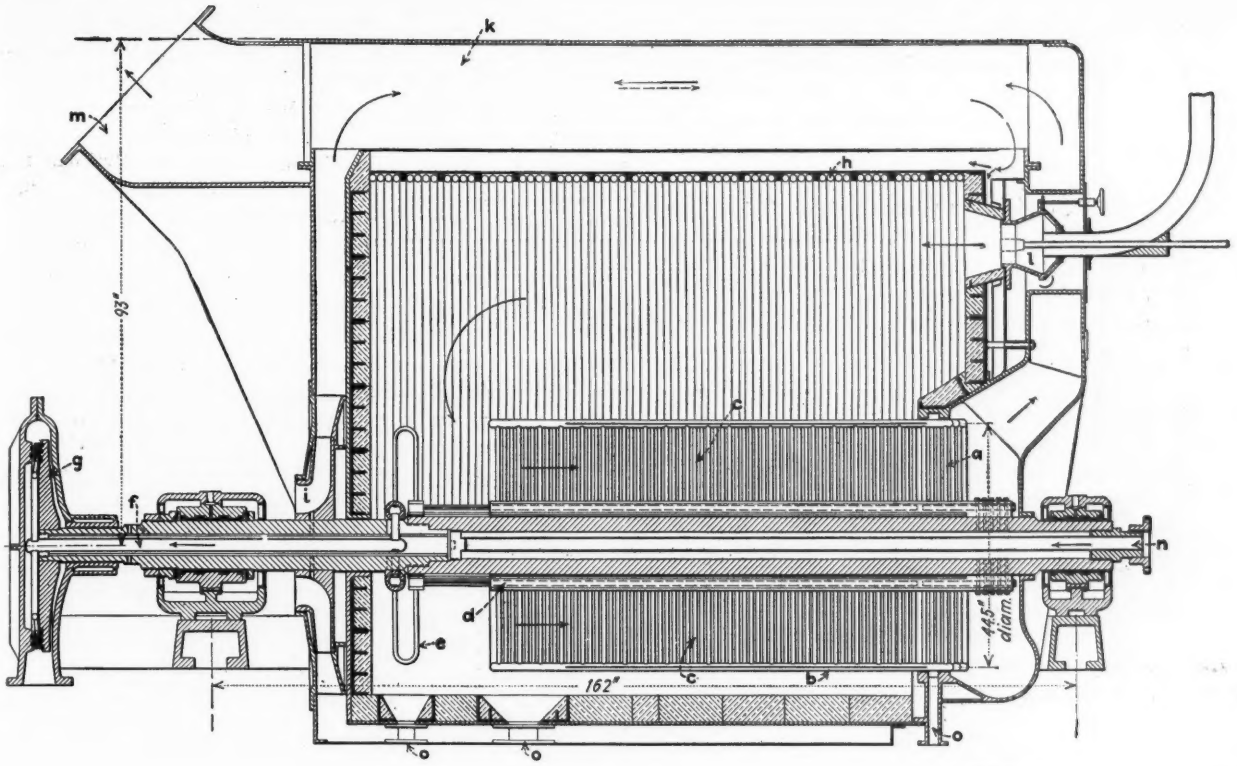
Fig. 5—Results of tests on the model

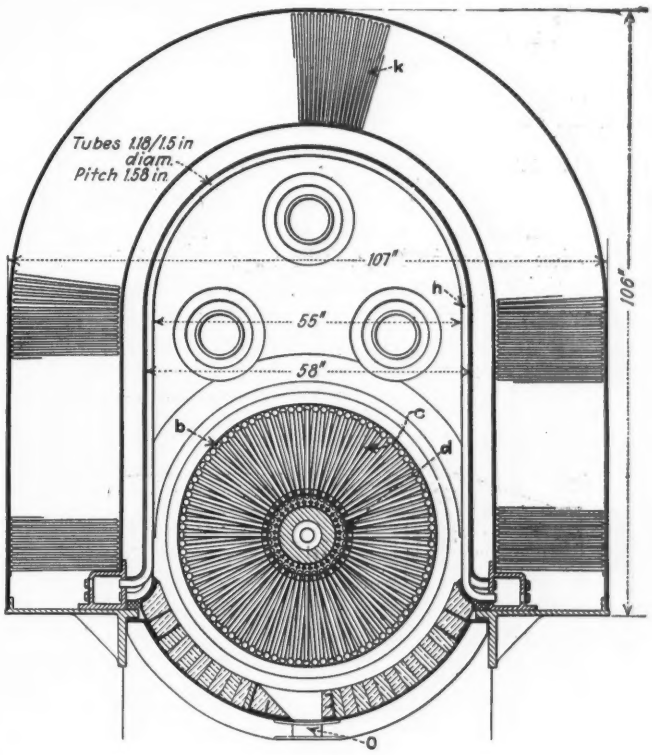
Relation of speed to increase in pressure. The plotted curve is calculated from the formula $p = Ma\omega^2 (\delta_w - \delta_s)$, in which M is the mass of the centrifuged column of 1 sq.cm. cross-section, a the distance of the center of gravity of this mass from the axis, ω the angular velocity, $(\delta_w - \delta_s)$ the difference of the densities of water and steam. The latter is assumed to be 1,000 kg. per cu. meter. The experimental values shown by plotted points were obtained on complete formation of steam in the steam generating pipes *b*, that is with valve *e* closed



desired back pressure. The expanded steam is led from the auxiliary turbine through reheater tubes *h* surrounding the furnace and can be led from there into a low-pressure turbine or elsewhere for further use.

At 85 per cent efficiency the unit shown in Figs. 6 and 7 should evaporate 4,000 lb. of water per hour. With an expansion of the steam from 1,700 lb. gage and 716 deg. F. to 356 lb. absolute pressure the auxiliary turbine gives an output of about 850 kw. For driving the steam generator, including the fresh air supply and the turbulence loss at the heating surfaces, about 200 kw. is required, so that 650 kw. remains as effective output.





Figs. 6 and 7—Design of a rotating steam generator with auxiliary turbine

Speed, 3,000 r.p.m. Steam output, 4,000 lb. per hr. Steam pressure before the revolving nozzles, 1,700 lb.—absolute. Steam temperature before the nozzles 716 deg. F. Expansion in the turbine to 355 lb. absolute. Reheating at 355 lb. absolute to 842 deg. F. Output to be delivered at the coupling, 500 to 600 kw. Heating surfaces: Evaporator 710 sq.ft., high-pressure superheater, 21.5 sq.ft., reheater, 376 sq.ft. (full circumference of tubes).

Legend: *a* Water supply tubes, *b* and *c* evaporator tubes, *d* steam collectors, *e* high-pressure superheater, *f* steam collector tube, *g* turbine, *h* reheater, *i* fresh-air compressor, *k* air heater, *l* burners, *m* waste-gas flues, *n* water supply pipe through the hollow shaft of the coupled generator, *o* ash and dust discharge connections.

In the intermediate superheater the steam at 356 lb. absolute pressure is reheated to 842 deg. F. The difficulties that arise in connection with reheating in super-high-pressure plants are simply solved by this assembly of boiler and auxiliary turbine.

Such a unit requires no regulation of the automatic return of condensate. The water flows to the boiler at low pressure, and the amount of water entering is regulated in proportion to the evaporation, which in turn depends only upon the rate of heat supply. The quantity of water running into the steam generator adapts itself automatically to this rate of heating. Fittings for super-high-pressure steam can therefore be omitted.

For complete evaporation of the feed water it is obvious that quite pure water must be used. The automatic return of condensate must therefore be as free from loss as possible. Owing to the absence of high-pressure connections, fittings and piping, the conditions in this respect are favorable in the plant described.

Rotating Greatly Increases Heat Transfer

Measurements for heat transmissions were made on the experimental model. At speeds of 1,500 to 1,600 r.p.m. and under the conditions present in this model, heat transmission figures of 52 B.t.u. per sq. ft. per hr. per deg. F. temperature difference were shown. It is to be expected that at higher speeds and greater axial velocity still better heat transmission will be obtained, so that such boilers can operate on a heating area (of the rotating, heat-absorbing surfaces) only one-fifth or one-sixth that of the normal boiler. *(over)*

Fan Action of the Rotating Boiler

The steam generator shown in Figs. 6 and 7 produces the same fan action as takes place in the model first described. The furnace gases are forced out through the flue at the right and the hot gases are sucked in at the other end of the rotor.

The efficiency with which the furnace gases are moved plays no direct role in this case, as the converted energy which is not effective for conveying the furnace gases serves as eddy work to improve the heat transmission of the heat-absorbing surfaces.

Dust Elimination and Automatic Gas Removal

It can be seen from Figs. 6 or 7 that the steam generator-rotor is closed at the outer circumference like a drum. Only at the inlet (at the left) for the furnace gases is the heating surface open at the periphery, so that the particles of ashes and dust can be flung out there. The expelled particles are caught in hoppers *o* in the lower part of the casing-shell and are carried away by compressed air. The furnace gases that serve to carry off the ashes need amount to only 2 to 3 per cent of the total quantity. Their excess pressure at the hopper will, in most cases, be sufficient for the pneumatic transportation of the fly ash.

As the fly ash that comes in contact with the rotating heating surfaces is still in soft condition at the time of impact, the resulting wear and tear must be small.

In the steam generator described we can count on furnace heat releases of 330,000 to 560,000 B.t.u. per cu.ft. per hr. because of the high degree of turbulence.

Construction and Economy of the Plant

Of course great care is required in building a rotating steam generator to operate at 3,000 r.p.m. In the construction shown in Figs. 6 and 7 provision is made for the individual elements to be wedged into the longitudinal grooves of the shaft. The elements must be well made and the whole rotor balanced. As the rotating mass is comparatively small, only good special material need be considered. The shaft is heat-treated and is also protected from heat strains by the elements set around it, so that no severe stresses occur in this part. At steam pressures of 1,400 to 1,700 lb. absolute at the turbine nozzles, the peripheral velocity is 525 ft. per sec., accordingly far below the range usual in turbine construction. In the construction of the steam generating elements of Figs. 6 and 7 maximum stresses are 16,000 to 17,000 lb. per sq. in. At the prevailing temperature of about 660 deg. F. these can still be easily handled.

A comparison between the cost of a 4,000-lb.-per-hr. steam power plant—consisting of boiler, feed pump, fans, auxiliary turbine and generator—and a careful estimate of the new plant shows a saving of about 60 per cent in cost of construction.

The cost of the unit is even lower than that of a low-pressure boiler alone having the same evaporation, while the rotating power unit not only produces 4,000 lb. steam but also delivers 500 kw. net electrical output. The outlook for still lower manufacturing costs of the unit in question is very good, as the steam generating elements represent the main item of cost; by standardized mass production these elements could be manufactured much more cheaply. Not only is the initial cost of the power plant itself lower, but also the cost of the necessary buildings. By way of example, Fig. 8 pictures the space required for a high-pressure auxiliary plant using a vertical-tube boiler compared with the auxiliary plant shown in Figs. 6 and 7.

Field of Application

The steam generator-power unit described can be used in every power plant where liquid, pulverized or gaseous fuels can be employed for firing. Owing to its compact and light construction there will be a demand for the machine especially for vessels and vehicles such as ships, locomotives or the like. In these cases it can serve as an auxiliary plant for the normal plant or it can be installed as a complete primary power unit.

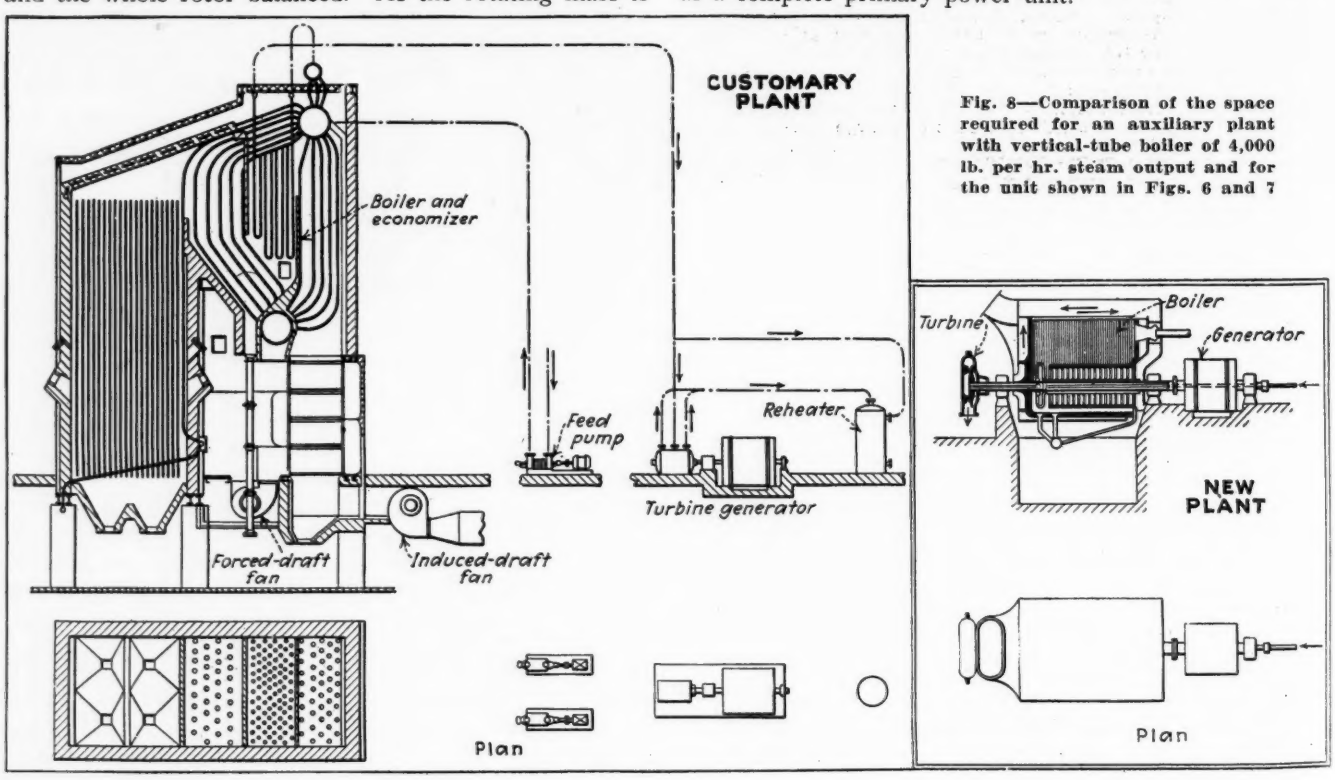
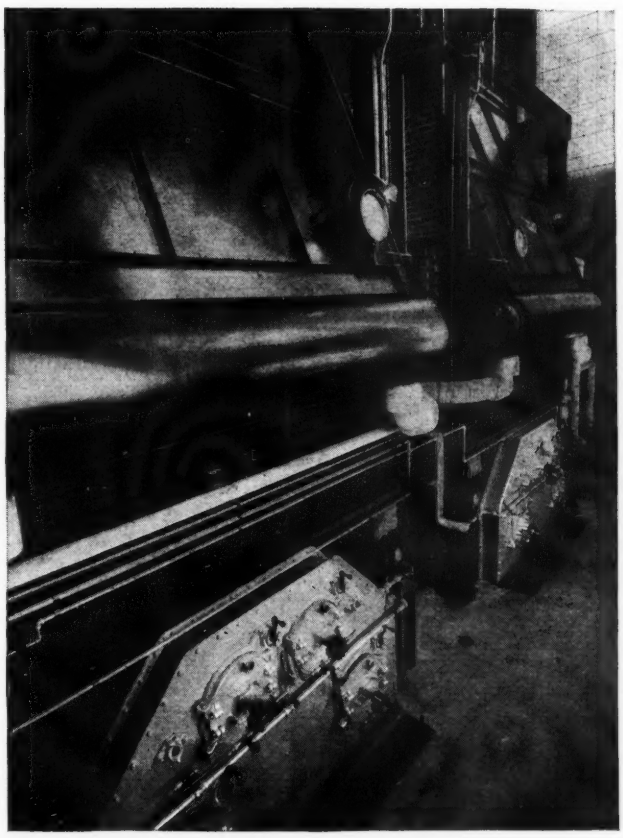


Fig. 8—Comparison of the space required for an auxiliary plant with vertical-tube boiler of 4,000 lb. per hr. steam output and for the unit shown in Figs. 6 and 7

LAUNDRY — ICE

KNICKERBOCKER COMBINES PLANTS



Two 4,000-q.ft. boilers supply steam for power and process

Power and steam generating equipment installed to serve the laundry is operated under supervision of the ice plant personnel

KNICKERBOCKER ICE CO., New York, N. Y., during September placed in operation a new laundry which was constructed adjoining the Company's 200-ton ice plant in Long Island City. By locating the laundry next to the ice plant it was possible to make several operating economies, both in the laundry and in the ice plant.

The ice plant is operated on purchased power, but a boiler plant and engine generating set are installed to provide process steam and electric energy for operating the laundry. The plant is arranged so that the engine-generator set is operated by the ice plant personnel, the only additional labor required by the laundry power plant being that in the boiler room. A further economy is secured by combining the water services of the laundry and ice plant.

Steam is generated in two 4,000-sq.ft., low-head, bent-tube type boilers designed for 198 lb. pressure. The boilers are fired with oil by four burners per boiler. Natural draft is used, but an air duct under the boilers has been provided in case forced draft is required by subsequent increase in boiler load.

The engine-generator set, of 200-kw. capacity, is installed, together with the switchboard, in the ammonia compressor room of the ice plant. It exhausts through an oil separator to a deaerating feedwater heater and to an instantaneous heater, 18 in. in diameter and 6 ft. long, for heating laundry wash water. The demand for exhaust steam for these purposes does not utilize all of the exhaust steam during the summer months, though it is expected that little exhaust will be lost to the atmosphere during the winter. In addition to exhaust steam, the laundry requires 100-lb. steam for the ironing equipment. This is supplied through a reducing valve.

Feedwater is supplied to the boiler by tilting return traps and also by two 10 x 6 x 12-in. simplex feed pumps. Condensate from the instantaneous water heater and make-up water is heated in the feedwater heater, which is located so that the heated water flows to the pumps by gravity. Condensate returning from the ironing equipment in the laundry is collected in a receiver tank, which is inter-connected with tilting return traps above each boiler. This condensate is returned direct to the boiler drum by the traps, thus saving the heat that would be lost by flashing of the high-temperature condensate.

Before the laundry was built, ammonia condensing water was cooled in a spray pond on the roof of the ice plant. As soon as a well now being driven is completed, operation of the spray pond is to be discontinued, thus saving pumping energy and spray pond maintenance costs. Water from the wells, after passing through

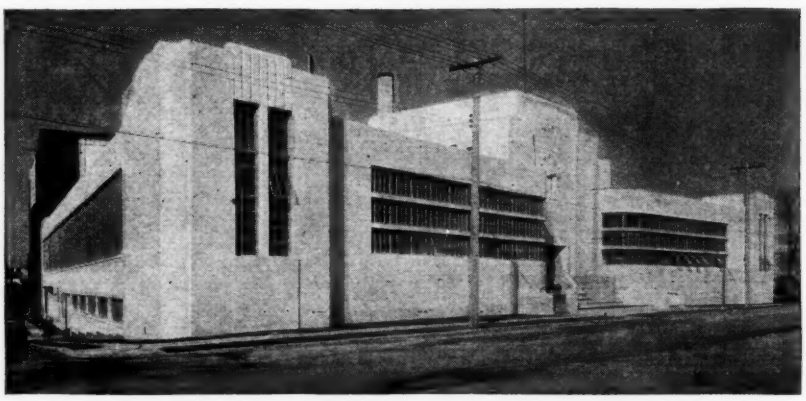
zeolite water softeners and the ammonia condensing equipment, will be stored in two 50,000-gal. outside storage tanks from which water for the laundry will be drawn as required by a 12 x 14 x 18-in. simplex pump.

Heat Reclaimer

Water to be heated for the laundry first passes through a heat reclaimer which recovers heat in the dirty wash water before it is discharged to the sewer. This heat reclaimer consists of a tank 4 ft. by 7 ft. by 14 ft. long, partitioned by baffles so that the waste water is forced to make six passes over coils through which the water being heated flows. This heat reclaimer is capable of heating 11,000 gal. per hour from 65 to 100 deg. F. Water from the reclaimer is delivered to a 6-ft. diameter, 15-ft. high hot-water storage tank. The instantaneous heater operates in parallel with the storage tank.

Washed Laundry Air

Provision has been made for supplying washed outside air to the laundry. This fan and washer equipment, having capacity to produce an air change every three minutes, is located on the ice plant roof. The capacity of the exhaust fans is considerably less than that of the supply fans, so that air circulation is always out of the laundry, thus preventing outside dust and soot from entering and settling on the clean laundry. Fin-tube heating coils are provided before and after the spray washer to prevent freezing of the water in the winter and to temper the air before delivery to the laundry.



The ice plant roof, which carries the spray pond, can be seen in back of the laundry building

Considerable steam is usually required to maintain heavy-gravity fuel oil flow in a circulating system during winter months. Here are two ideas for cutting steam costs, in a compact, efficient installation

LESS HEAT FOR CIRCULATED OIL

By W. J. TANGERMAN
Shop Supt., Union Metal Products Co.

A SHORT time ago, it seemed advisable to change over our existing set-up for gas-fired furnaces and a coal-fired steam boiler to an oil-fired system for reasons of economy. Since the buildings to which fuel oil must be circulated are spread over considerable area, and the number of outlets for the oil is large, it was essential that we produce at once an efficient and economical set-up. The resulting design is described in subsequent paragraphs.

Essential elements of the pump-house portion of the circulating systems are illustrated in Fig. 1. The basic need is to supply oil to three buildings, a forge shop, a steel fabricating shop, and a boiler room, and it is desirable to have this circulation centrally controlled and with a central storage system where oil may be unloaded from tank cars.

The set-up, as we worked it out, consists of three separate circulating systems, interconnected to permit

maximum flexibility in oil supply. An additional advantage of the separate circulating system is the possibility of gaging exactly the oil used in each department. Main pump-house equipment, which is in duplicate, consists of pumps which unload at the rate of 90 gal. per min. to 24,000-gal. storage tanks and 18-gal.-per-min. pumps for circulation. Electrically operated Viking pumps are used for the unloading and circulating systems, and the metering is done by King-Seeley telegages which meter directly by weight, hence are not influenced by changes in volume due to temperature. The oil used is 18 Bé. gravity during the summer months and 14 Bé. gravity in the winter. Oil is heated in winter, but not during the summer, hence the difference in gravity.

Pipe-line crossovers, all of which are not illustrated in the diagram, permit oil to be pumped directly from the tank cars to any one of the three circulating systems through the principal storage tanks, to storage tanks at the forge shop substation, to storage tanks in the boiler room or from any tank to any substation, all by means of the unloading system. Another set of crossover connections permits oil to be circulated by means of the circulating system from any of the tanks to any other tank or from the tanks directly to any circulating system. The present installation includes a pumping substation at the forge shop with a 12,000-gal. tank at that point. This substation may be cut out entirely, however, and oil pumped under pressure to the forge shop system.

Clearing Circulatory System

In the past, a decided lack of economy has resulted from the necessity of maintaining circulation in the circulation system throughout the night in order to prevent blocking of the line. This is particularly true in the winter months when steam must be used for heating the oil 24 hours a day. This has been avoided in this system by tapping in air connections which force the oil out of the line back into the tanks at the completion of each day's operation. It is then necessary to maintain heat only in the principal storage tank, and even this may be avoided if desired.

Instead of the usual horizontal or vertical coils or helical coil about the walls of the supply tanks, we are using the oil-heating arrangement diagrammed in Fig. 2. Though the tank is 14 ft. in diameter and 21 ft. high, the oil-heating coil is composed of only 30 ft. of $1\frac{1}{2}$-in. pipe formed in a 16-in. coil 36 in. high. The return oil line at first entered at the top of the coil, with the oil intake at the bottom in order to permit the tank to be drained. Oil is delivered to the circulating system through a Whitlock oil heater in the pump house, using steam at 5 lb. pressure. By this combination of heating methods, circulating oil left the pump house at 130 deg. F.

This method of heating the oil in the tank is exceedingly economical of steam, since the small-diameter coil at the tank center heats only the oil necessary for the circulating system. The remainder of the oil in the tank, while heated by convection currents, nevertheless acts as a partial insulator.

Further Steam Economies

After this set-up had been in use for some time, we decided that further steam economies might be effected by altering the heating arrangement to that shown at *B*, Fig. 2. This consisted of adding a 6-in. diameter pipe 18 in. long from which the intake is drawn. Both ends of the 6-in. pipe were closed with welded-on plates. The top one has a single $\frac{1}{2}$-in. hole to permit the escape of entrapped air, and the lower one has a number of punched $\frac{9}{16}$-in. holes annularly around the intake to permit the entrance of make-up oil. The return line was moved from the top to the side, just above the intake, in order that the heat in the returning oil could be utilized most effectively.

This simple change raised the temperature of the oil entering the circulating system from 130 to 160 deg. F. The steam coil might now be shortened to 18 in. in height and a jacket provided to cover the coil. This would increase the economy still more. Possibly greater heat would result if the oil intake were at the top of the 6-in. pipe, but this would not permit the lower 18 in. of oil in the tank to be drained out for use.

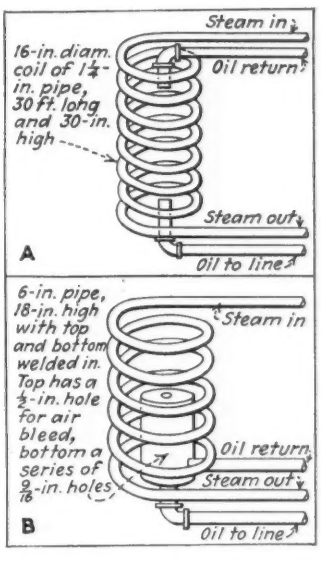

Steam in
16-in. diam. coil of 1¼-in. pipe, 30 ft. long and 30-in. high
Oil return
Steam out
Oil to line
A
6-in. pipe, 18-in. high with top and bottom welded in. Top has a ½-in. hole for air bleed, bottom a series of 9/16-in. holes
Steam in
Oil return
Steam out
Oil to line
B

Fig. 2—Old and new coil arrangements

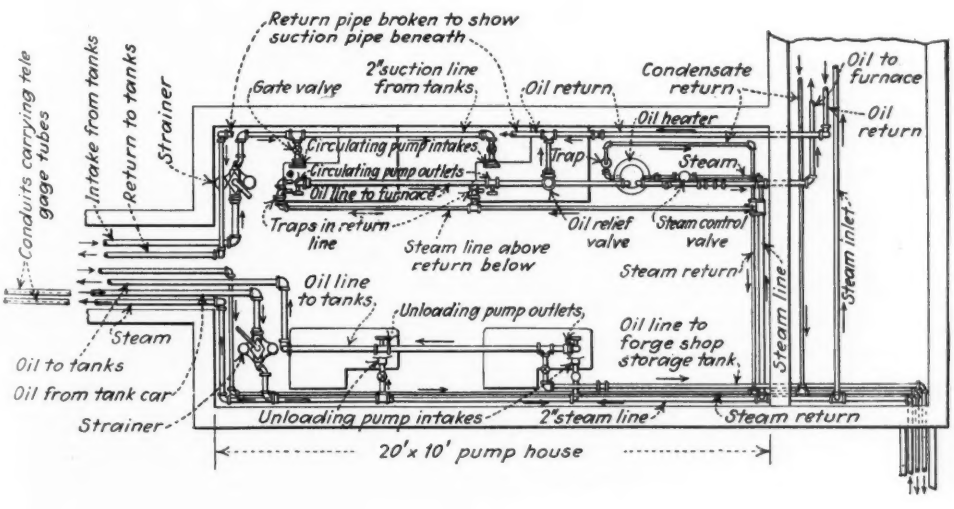


Fig. 1—The principal pumping station. Lines lead from here to the furnace circulating system and to the forge shop tank. Future lines will be laid to the boiler house. The forge shop line may be crossed over to return oil to the pump house, and has an air connection at its opposite end to clear the line

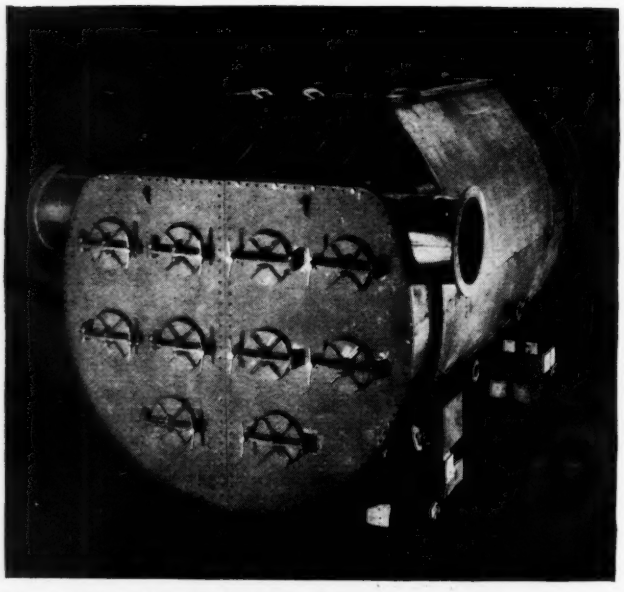


Fig. 1—The all-welded condenser

By CLETUS F. FOX
Mechanical Designer,
Ross Heater Company

Replacement of castings by steel plates, arc-welded, made a gross saving of 41 per cent in the cost of construction of the surface condenser for a 35,000-kw. turbine. Mr. Fox's paper, here presented in abridged form, won a $100 prize in the second Lincoln Arc-Welding Prize Competition*

ALL-WELDED STEEL CONDENSERS

THE intent of this paper is to show the practical and economical method by which the time-honored custom of building condensers of cast iron can be advantageously changed to steel plate construction by the arc-welding process.

The comparison is based upon a unit approximately 30 ft. long, 16 ft. wide, and 20 ft. high, the shell and parts being of steel plate arc-welded without a single casting, tubes and tube sheets being of a brass composition. This unit was completed during the summer of 1931 and is now serving a 35,000-kw. turbine.

The figures relating to cast-iron construction are averages of cost figures taken from current files on units of sizes approximating the above.

In the usual cast-iron design every section joint is a chance for air leakage; every joint requires a flange faced and drilled with gaskets and bolts. Much labor and equipment are required in the field for assembling the many sections that go to make up the unit. A cast-iron unit of this size must be provided with spring supports to carry part of its weight, as the total weight of this unit is too great to be suspended entirely from the turbine. Flanges, walls, and ribbing are approximately twice as thick as required by steel plate construction.

Fig. 1 shows the corresponding steel plate all-welded unit. Attention should be called to several points. First, the absence of flanges and bolts with their attendant leakage is noted in the shell proper. This point alone is of unparalleled importance. (The longitudinal joint with dowel clips was completely welded in the field, making the shell proper complete without joints.) Second, this joint was the only one to be made up in the field and required approximately 36 hours of welding. This is another saving in field labor. Third, consider the pleasing lines of this unit. Fourth, and very advantageously, this unit was entirely suspended from the turbine, eliminating spring supports and their necessary foundations. The supports shown can be removed after erection and testing. Attention is called to the flange thickness and appearance of the access doors and to the clean-cut appearance of the many openings for pipe connections.

The accompanying figures (presented in tabular form on the next page) are given as percentages of the gross shop cost, using cast iron as a basis.

This saving was made in spite of the fact that the unit, being the first of this design in welded steel, was unfamiliar to all connected with its fabrication; consequently some time was lost on its schedule through the shop. The method and procedure of fabrication will be outlined to give some idea of the economies in shop assembly. First of all, it was necessary to obtain a general shape and outline most economically suited for welding and with pleasing appearance. With this in mind the size of the unit was determined and railroad clearance obtained to destination. It was found that these would allow the shell proper to be made in two pieces, leaving only the longitudinal seam for field welding.

With this point settled, a stress diagram was laid out to fit in with the most economical plan of welding and assembly of parts. From this diagram the thicknesses of shell plate, flanges and reinforcing strips were selected to keep stresses at critical points within safe limits. It was necessary to take care of approximately 900,000 lb. total collapsing load on each side of the unit, plus the stress due to its own weight when suspended.

Copper-bearing steel plate was used. It is corrosion resisting and has physical properties equivalent to commercial flange-quality steel. This necessitated the use of welding rods of the same material. Test specimens previously prepared showed the joint efficiency of a

*Sponsored by the Lincoln Electric Company of Cleveland, Ohio, which will later publish many of the prize papers in book form.

reduced section-double Vee weld to be from 95 to 97 per cent and of a reinforced section double-Vee weld to be as high as 125 per cent of the parent plate. Reinforced welds were, therefore, used throughout as shown in Fig. 3.

The customer specified tube sheets of Muntz metal. Since this material can not be welded, the sheets had to be bolted to the unit, necessitating flanges on the shell and water boxes. These flanges were forged from steel bars to fit the contour of the finished unit.

After the plates, flanges, and reinforcings were formed to shape, the water boxes were built up and completely machined and drilled, including nozzles, partitions, etc., for these were to be used as templets and jigs to assemble the shell sections.

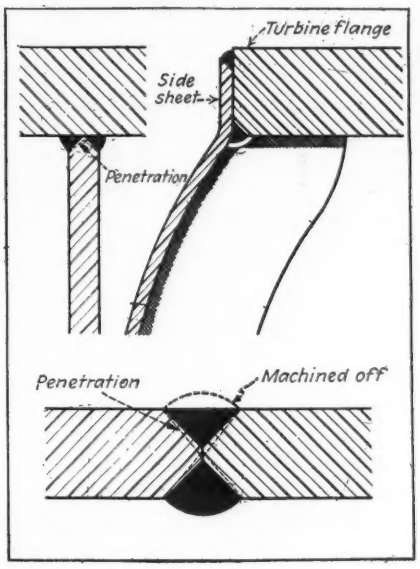
Water boxes were of the same form as the shell, with plate rolled to shape and welded to the flanges. Upon each of these boxes was a cover made of steel plate in two section and bolted in place for removal when replacing tubes. Each cover was equipped with several quick-opening covers of all-welded construction.

In Fig. 4 the water boxes are shown assembled to the lower half shell. From this point to the finish of the fabrication, the procedure was simply one of placing the different sheets and flanges in their respective locations and welding the joints.

The turbine flange at the top was built up by the welding of four pieces of rolled steel plate 3 in. thick and 6 in. wide. These were machined, drilled and placed in the opening formed by the top edges of the side sheets. This flange had to be aligned as perfectly as possible. Upon this alignment depended the trueness of all other flange faces, since the unit was suspended from this flange. An accurate check of the flange after it was completely welded in place showed a variation of less than $\frac{1}{32}$ in. diagonally across the corners. The bolt holes in the flange were in perfect alignment with the centers of the unit. The type of weld used is shown in Fig. 2.

The time saved by welded steel construction is no small item; this unit was completed thirty-seven working days after the drawings were sent to the shop. With cast-iron construction a large amount of this time would be used in making up the necessary patterns, to say nothing of the molding, casting and excessive amount of machining and drilling.

Fig. 2 (Right) — Typical joints, showing reinforced welds



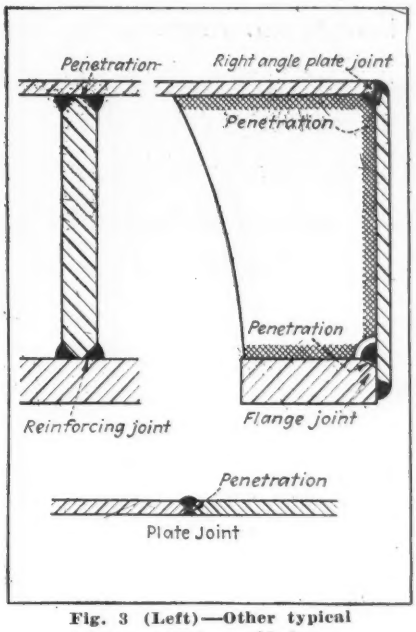


Fig. 3 (Left)—Other typical joints used in welded condenser

Comparative Cost Data

Cast-Iron Unit	Per Cent	Welded Steel-Plate Unit	Per Cent
Patterns	8.2	Patterns	0.0
Pattern storage	0.8	Pattern storage	0.0
Castings	51.1	Castings	0.0
Bending plate and flanges	0.0	Bending plate and flanges	1.0
Steel Plate	0.0	Steel Plate	16.2
Machining and drilling	19.0	Machining and drilling	9.1
Tube sheets	16.9	Tube sheets	16.9
Welding	0.0	Welding	13.3
Bolting	3.0	Bolting	1.5
Gaskets	1.0	Gaskets	0.5
Totals	100.0		58.5

Fig. 4—Water boxes assembled with partly completed shell

▼ ▼ ▼

"Power" Bound Volumes

A READER writes, stating that one set of bound volumes of *Power*, covering the period from July, 1914, to and including June, 1919, is available. Any reader interested in the purchase of such a set should get in touch with the Editorial Department of *Power*, which will forward his letter.

Supercharging increases diesel capacity and reduces cost per horsepower. The question, "Does it pay?" cannot be answered in the abstract; blower design and operation are vital factors. Here is a summary of the latest supercharging practice

▼

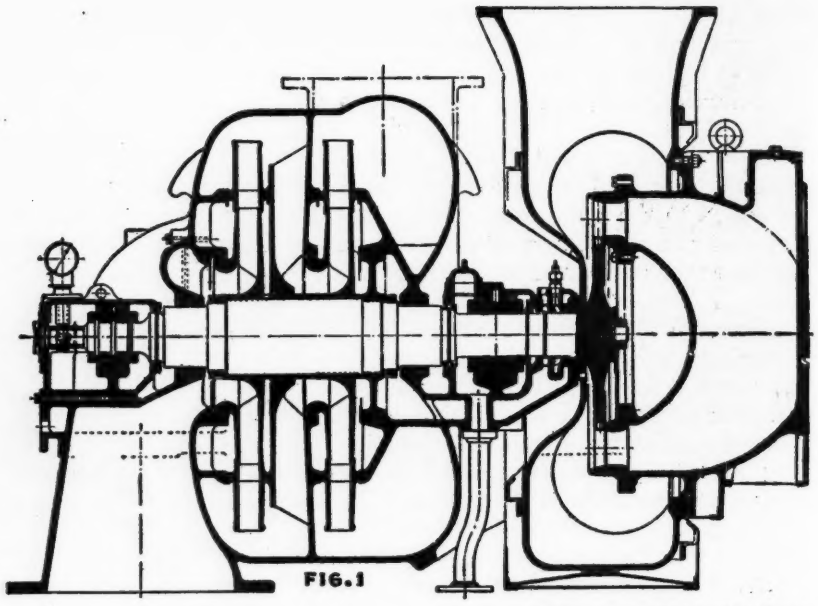


Fig. 1 — Exhaust-turbine supercharger, consisting of exhaust gas turbine and a turbo-compressor mounted on the same shaft

INCREASING THE CAPACITIES OF EXISTING DIESELS

THE general subject of supercharging has been given an increasing amount of attention during the past several years by all engineers who are directly interested in internal combustion engine work, and many installations of engines with supercharger equipment are in every-day service abroad and functioning with entire satisfaction. It must, therefore, be admitted that the correctness and practicability of the supercharging principle has been amply demonstrated. This fact suggests the natural question of why the use of supercharging is restricted to so relatively few installations.

The advantages of supercharging, particularly as applied to 4-cycle diesel engines, have been so fully pointed out and freely discussed in numerous recent articles in the technical press that further discussion would be superfluous. Undoubtedly supercharging will increase brake horsepower output from 40 to 50 per cent, thereby presumably permitting the engine to be sold at a substantially reduced price per rated horsepower—and this without detrimental results from overheating or impaired fuel economy.

However, when one examines the existing supercharger installations in connection with 4-cycle engines, it is found that the great majority of these superchargers are of the exhaust turbine type and are used on large engines where operating conditions involve long runs at fairly constant loads.

The bulk of the diesel-engine business thus far, however, is in engines of less than 500 hp. installed in stationary plants where load conditions are extremely variable. Superchargers are rarely used on engines of this size and service classification, which must be due to the fact that superchargers are relatively too expensive for use on the smaller-size engines or are unsuited in operating characteristics to the demands of variable-load operation of stationary installations.

A brief consideration of available superchargers will serve to indicate the accuracy of this view.

An exhaust-turbine supercharger, Fig. 1, consists of an exhaust gas turbine and a turbo-compressor mounted on the same shaft. Such a machine is quite expensive and becomes commercially practical only when applied to engines of large horsepower, particularly where long periods of operation at heavy loads tend further to justify its use, as in marine installations. It automatically adjusts itself to variable load conditions, but requires very careful analysis and predetermination of exhaust conditions for best results. Obviously, being driven by exhaust gases, its operation is independent of the direction of engine rotation. For the apparatus to be successful it is necessary for the exhaust lines from each cylinder to be analyzed so that there is no interference between the gas pressure waves issuing from the cylinders. Usually two manifolds are needed, and these are connected to separate nozzle boxes of the turbine as shown in Fig. 2. Obviously the mechanism is expensive, especially when applied to existing engines, and becomes prohibitive when the engine's normal rating is below 500 or 600-hp.

Exhaust gas turbines, however, recover part of the energy in the exhaust gases which is wasted in the non-supercharged engine. The increase in engine capacity

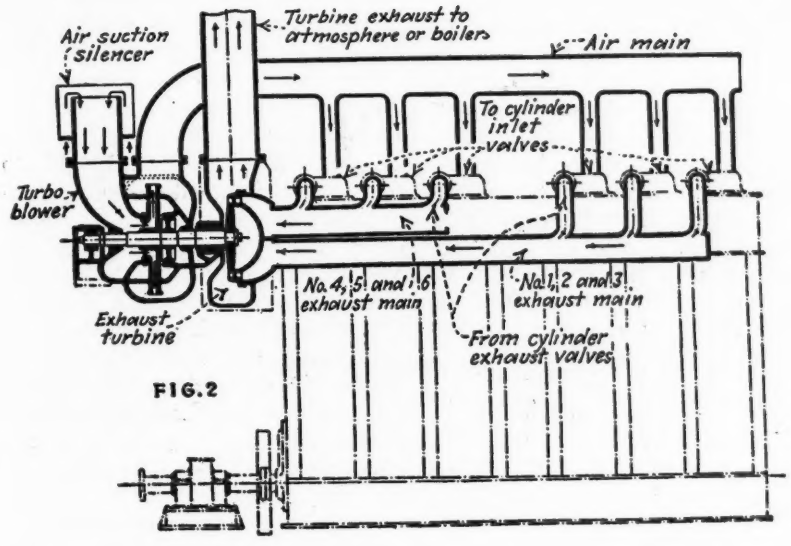

Air suction silencer
Turbine exhaust to atmosphere or boiler
Air main
To cylinder inlet valves
Turbo-blower
No. 4, 5 and 6 exhaust main
No. 1, 2 and 3 exhaust main
Exhaust turbine
From cylinder exhaust valves

FIG. 2

Fig. 2—Two manifolds are usually needed, connected to separate nozzle boxes of the turbine, in order to avoid interference from gas pressure waves issuing from the cylinders

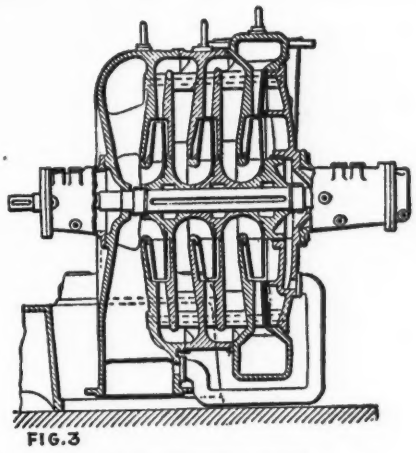


FIG. 3

Fig. 3—Geared turbo-compressor of the type which may be driven directly from the engine

of about 50 per cent is obtained at no sacrifice in thermal efficiency. For this reason the exhaust gas supercharger is logical for large units, and it is surprising that American engine builders are not doing more with it. The cost now ranges from $5 to $7 a horsepower so that with a 1,000-hp. engine costing $35,000, the additional investment of $5,000 would give 1,500 hp. at a total investment of $42,000, or less than $27 a horsepower.

A geared turbo compressor, Fig. 3, may be driven directly from the engine through step-up gears. Due to the widely different speed characteristics of the engine and the compressor, and the resultant high-ratio gear drive required, this type of supercharger is rarely, if ever, applied to low- or moderate-speed heavy-duty engines. Furthermore, as such a compressor must always operate in one direction, it obviously cannot be used on direct-reversing marine installations.

A modification of this apparatus has been adopted on certain engines for scavenging purposes, but there is no reason why the blower capacity cannot be increased to give a supercharging effect.

There are various types of rotary compressors, such as Fig. 4, available for supercharging service, which

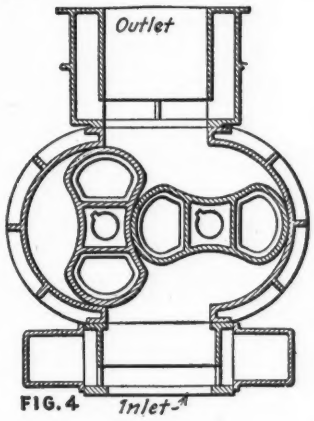


FIG. 4

Fig. 4 — Rotary compressor suitable for supercharging service, driven directly from the engine

can be driven directly from the engine through simple low-ratio gear or chain drives and which are quite acceptable from the viewpoint of relative price of engine and supercharger. These compressors will serve admirably as superchargers under constant-load conditions, but unfortunately, none of these machines is adaptable to capacity regulation of air supply to meet the demands of varying engine loads except by the very uneconomical methods of throttling at the intake or of bypassing on the discharge side. The use of such a machine in a capacity necessary to realize the full possibilities of supercharging at maximum loads therefore involves such a power loss and consequent poor economy at the lighter loads as to render its general use inadvisable.

In this country two known applications have been made. In one case an engine installed in Colorado was provided with such a blower to give sea-level rating. In the second instance an engine was provided with a blower to give an increased output when the plant load grew beyond the engine's normal rating, but so far the blower has not been put into service.

The impracticability of using existing types of rotary compressors on direct-reversing engines, due to reversal of air flow with reversal of rotation, precludes the use of these machines on direct-reversing marine engines where lack of control of air capacity might not be so objectionable as in stationary power plant work.

The general considerations outlined above would seem to indicate that there should be a broad and useful field for a type of supercharger possessing the following characteristics: Reasonably low first cost, comparable to present types of rotary compressors; suitable control of discharge capacity without undue power loss and reversibility of direction of rotation without reversal of direction of air flow. An attempt to meet these qualifications is shown in Figs. 5 and 6.

Attention is here called to the fact that whereas the discussion has dealt exclusively with superchargers for 4-cycle engines, the design of the machine in Figs. 5 and 6 embraces characteristics that render it equally useful and desirable as a scavenging compressor for 2-cycle engines.

By reference to Figs. 5 and 6 it will be seen that the unit consists of an outer stationary case *C* within which is placed a rotating drum *D* whose outer surface is machined to afford a seal with the outer casing, and whose inner surface is shaped to conform to the paths swept by

the vanes E. The drum is driven by a suitable shaft F passing through the left-hand end of the stationary case; the right-hand end of the drum is provided with a bearing H floating on a fixed stub shaft G. The vanes are fixed to short shafts I whose outer ends are provided with pinions J meshing with gear quadrants K, Fig. 7, as shown. The two quadrants are coupled by a chain which also passes over two pinions L keyed to an arm M, which has a central bearing eccentrically placed on the stub shaft. The result of this arrangement is that as the drum revolves the eccentric bracket also turns but about a center removed from its bearing center. This causes the chain to rotate, which action in turn swings the vanes. The position of the drum, case and vanes are shown for three positions in Figs. 7 to 9.

To obtain variable displacement volume the lever N at the end of the stub shaft may be shifted to swing the eccentric M carrying the chain bracket. The bracket then swings through a smaller arc and the vanes make a smaller swing in the casing, thereby displacing less air volume. The three positions outlined in Figs. 7 to 9 show the relative positions of the parts during a rotation of the shaft.

From a further consideration of the operating characteristics, it will be observed that as the angular displacement of the pin M is continued beyond that point at which the discharge capacity is reduced to zero, there will take place a reversal in the direction of the air movement betwen the two chambers. If this displacement is continued to 180 deg., the capacity of the machine will be restored to maximum, but with a reversed direction of air flow. This air flow can now be restored to its original direction only by reversing the direction of rotation of the machine. It is, therefore, equally obvious that the direction of rotation of the machine may be reversed without reversing the direction of the air flow if the pin M is simultaneously subjected to angular displacement beyond that position which corresponds to zero discharge capacity, and maximum discharge capacity will be available for the reversed direction of rotation when the pin is displaced 180 deg. from its original position with its axis in the vertical plane.

The mechanism for adjusting the effective displacement capacity of the compressor provides a simple, practical means of graduating the air supply of a diesel engine in proportion to the load. Since the machine permits the reversing of the rotary compressor without changing the direction of the air flow through it, it should be adaptable for the reversible diesel engines used for ship propulsion.

More Expensive

This type of compressor costs more, undoubtedly, than will those shown in Figs. 3 or 4. Its advantage is the variation in capacity, which is necessary for an engine operating at a variable load. A constant output blower calls for too much power when the engine is running underloaded.

Regardless of the particular type of blower finally chosen, owners of oil engines now operating at maximum capacity would do well to investigate the feasibility of supercharging before purchasing additional engines.

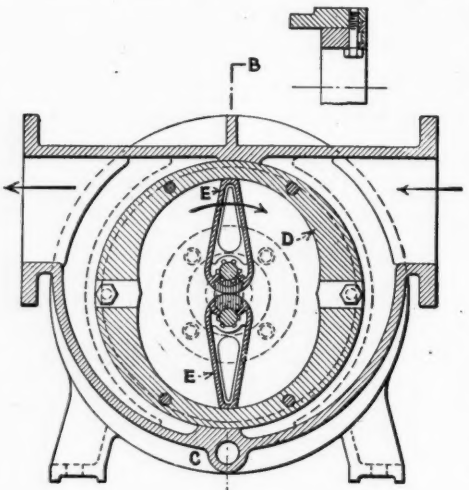


FIG. 5 Section A-A

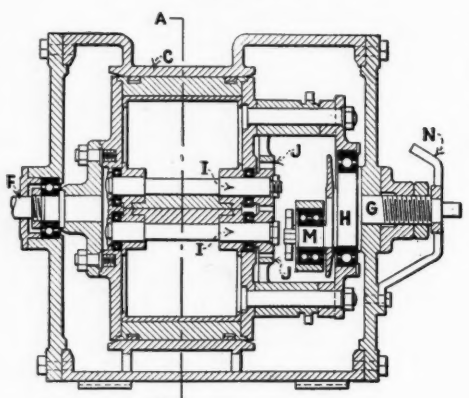


FIG. 6 Section B-B

Fig. 5—A supercharger suitable for either 4-cycle or 2-cycle engines

Fig. 6—Cross-section of the supercharger of Fig. 5

Figs. 7-9—Three positions of the parts during one revolution of the shaft

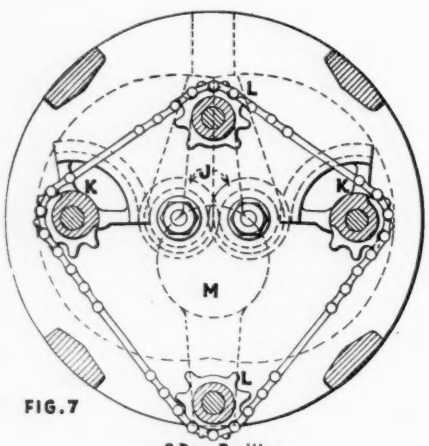


FIG. 7 0-Deg. Position 180 Deg. to Other Hand

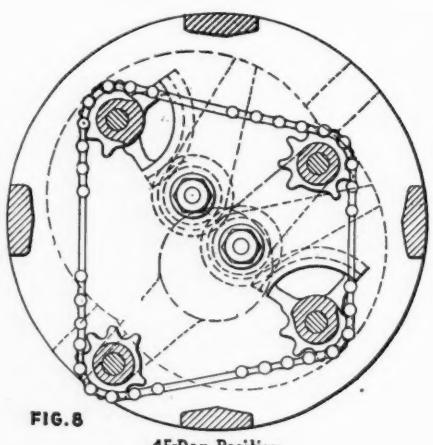


FIG. 8 45-Deg. Position 135 Deg. to Other Hand

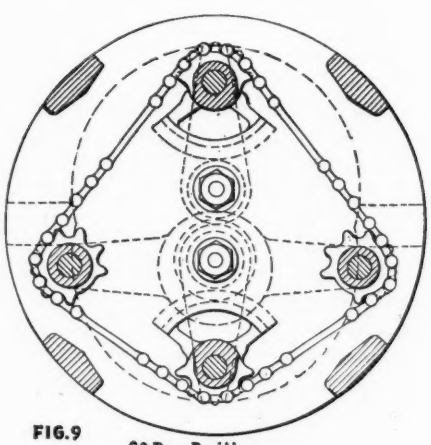


FIG. 9 90-Deg. Position

PROPER CONTROLLER MAINTENANCE

Increases Motor Reliability

Proper maintenance is usually the key to long-term dependability. This fact makes particularly valuable this description of the maintenance practice in one large plant that has reduced the cost of motor and controller upkeep and increased their operating reliability

By MARIN PHILLIPS

A LARGE percentage of the causes for motors being out of service are chargeable to control equipment. Consequently, if a high motor reliability is to be obtained, controllers must be given regular attention. Controller maintenance practice here suggested is that followed by the author with good results in reducing operating costs and increasing reliability.

Heavy arcing at contacts is one of the chief causes of contact wear. To keep this at a minimum, arc chutes and blowout coils should be kept in good condition. Excessive arcing of contacts may cause short circuits, rapid burning and frequent renewal of the contacts, overheating that will destroy contact-pressure-spring tension, and freezing of contacts closed.

Trouble was experienced on a magnet switch that periodically failed to open, due to the contacts sticking together from excessive arcing. An investigation showed that the insulation on the blowout coil turns was destroyed by the arcing. After replacing the coil, no more trouble was experienced.

Another cause of a contactor sticking closed was rebound of the switch when it opened. A lip on the under side of the armature prevented the contactor from opening too far. This lip became worn from a round to a flat contour, which increased the rebound sufficiently to make the contacts touch again after they had opened when the coil was deenergized.

On machines where considerable damage can result from the switch failing to open, as with hoisting and conveying equipment, the control equipment should be liberally rated and be given close attention. Requirements for reliable operation are sufficiently exacting in some cases to warrant using two contactors in series.

All switches must be maintained in good condition to prevent their surfaces from becoming rough due to arcing or poor contact. They must be changed or their surfaces dressed before they become too badly pitted. Light dressing can be done best by holding the switch closed and drawing emery paper between the contacts until they meet for the full width of their faces.

Contacts must be properly aligned by holding them closed when tightening the screw or bolt fastening them in place. They should be adjusted so all make and break at the same instant.

Contact-pressure springs must be in good condition. All bearings must work freely so that the contacts make and break with a snappy action. The cross-bar and space between them must be kept clean of all carbon and copper dust, to prevent a short circuit. The contact's rating must be ample for the service on which it is used, and it must be designed for the operating voltage.

When there is danger of a contactor switch closing on trip-out, it should be provided with a manual reset relay. This condition may arise on drives controlled by a float switch, or thermostatic control, or on any other starter having two-wire control.

When arcing tips are provided on contactors they must be kept in condition to take the burning when opening and closing and protect the main contacts.

If the armature of an alternating-current magnet is noisy and vibrates, it indicates that it is not sealing properly, or that the shading coil may be broken.

The interlocks or reversing contactors must be kept in good working condition to prevent the possibility of both closing at the same time and causing a short circuit.

Oil must be used sparingly, if at all, on contactor bearings, to prevent their gumming and sticking. Where it is necessary to use oil, apply a non-gumming brand.

The tripping contacts should be inspected when a magnet coil burns out, as sometimes sufficient current may have passed through them to weld them together. If this condition is not found and corrected, the starter will fail to trip when needed and may burn out a motor or damage machinery.

Drum-type controllers give little trouble when the contacts are kept clean and well lubricated with vaseline or other paste made for the purpose. Care must be exercised to see that proper spring tension is maintained on the contact fingers.

The care of compensator contacts is much the same as that of contactor switches. The contacts must be properly aligned, so that all make and break together. This is best accomplished by not using new contacts with old ones that have been worn considerably. It is advisable to have a spare contact board, if enough starters of the same type are used to warrant it. The spare board can then be kept filled with either all old contacts or all new ones. Then when it is necessary to change contacts in the starter, the board can be put in as a unit.

It is good practice to use only new contacts on the running side of the compensator, to insure good connections. The old ones taken off can be filed and dressed for use on the starting side.

A regular program for the inspection of all control equipment should be maintained to insure that all will receive proper attention. An inspection chart of some type, listing all of the equipment and showing when last inspected, will be helpful in maintaining the equipment in first-class operating condition.

ANOTHER PIPING PROBLEM SOLVED

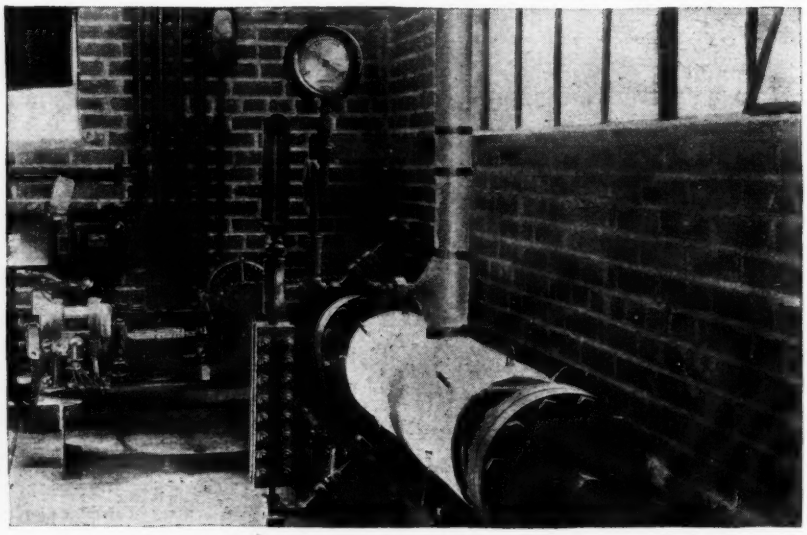


Fig. 1—Expansion-joint service tester operating in high-pressure laboratory

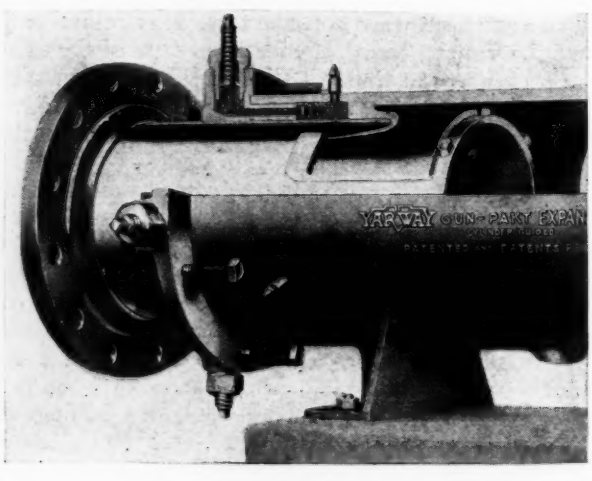
SINCE steam pressures and temperatures started rising some years ago, the design of piping systems and their component parts has undergone a complete revolution. Problems thought settled have arisen anew to trouble designer and operator. Fortunately, equipment designers are meeting this challenge. Several years of intensive work have improved piping systems at every vulnerable point.

High temperatures and pressures brought a number of difficulties with flanged joints. The joints were redesigned, new shapes and types of flange packing were developed and vastly improved operation was attained. Simultaneously, the welding of piping has made rapid strides, greatly reducing the number of flanged joints required.

Other problems arose and were solved in the design of expansion bends for high-pressure steam. In expansion joints of the sleeve type, the problem of packing, always important, became more so. Higher pressures called for the application of greater force to the packing gland. On the other hand, the higher temperatures not only increased the amount of expansion to be taken up, but shortened the useful life of the packing.

In the face of all this, the joint had to slide without undue friction, and remain tight. Ring and other packings for joints of these types were improved, but there has always been the necessity of packing replacement. This problem, even at moderate pressures and temperatures, is particularly difficult in mains which must operate for an entire heating season without shutdown. As leaks develop the glands are taken up, but when this is no longer sufficient it may be necessary to permit steam leakage for several months before pressure can be taken off the line so that the parts may be opened up and repacked.

Fig. 2—Part sectional view showing one end of newly developed expansion joint, force packed by "guns" on shell



Radically New Development

This problem of repacking has occasioned a radically new development, involving the application of plastic packing to sleeve joints by means of screw "guns." Expansion joints so packed are operating satisfactorily in a number of plants. The new type of joint was developed by the Yarnall-Waring Co., Philadelphia, and has undergone extensive service tests in that company's high-pressure steam laboratory, where it was recently seen by a member of the *Power* editorial staff.

The construction and method of packing the expansion joint will be made clear by reference to Figs. 2, 3 and 4. On the particular design shown, four guns are mounted to pack each gland. With cylinder *C* removed, and plunger *P* screwed up, a plug-shaped "charge" of packing is placed in *C*, which is then screwed into *G*. Plunger *P* is then screwed down, forcing the semi-plastic packing through a drilled channel into stuffing box *B*.

The deflector vanes *V* were developed experimentally to prevent steam pressures forcing packing back into *G* when *C* is removed while the expansion joint is operating. They meet this requirement at the highest operating pressures (at present 400 lb.) and also serve to give clockwise direction to the packing in *B* and thus prevent any tendency to pile up opposite the gun.

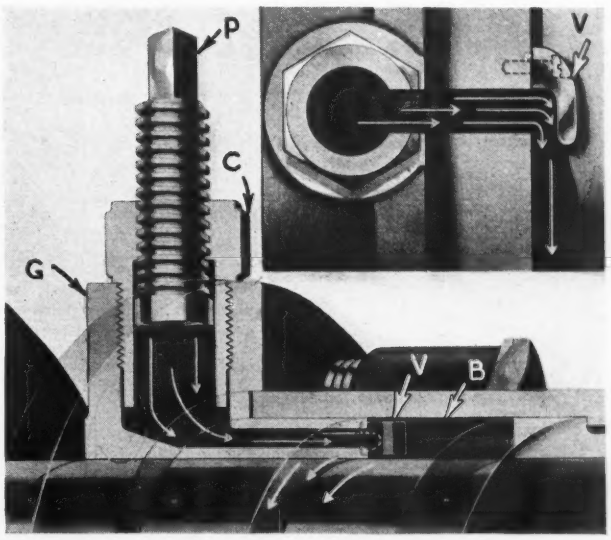
The packing material finally developed is a semi-plastic, heat-resistant, composition whose principal in-

gredients are long-fiber asbestos, graphite, and inorganic filler, impregnated with a high-test oil.

The Yarnall-Waring high-pressure laboratory, described in the Dec. 1, 1931, number of *Power*, has played an essential rôle in the development of this expansion joint and packing. Its feature is a 2,500-lb. pressure gas-fired water-level boiler. Using steam from this boiler (operating at 400 lb. pressure for these particular tests), the new joint has for several months been undergoing an accelerated service test.

Fig. 1 shows the expansion joint tester. The sleeve at the left is "Gun pakt," while that at the right is of the usual gland-packed design. The two are spaced rigidly by a rod and move back and forth (8-in. stroke) at the rate of 10 strokes per hour. This motion is produced by a screw (left) riding in a nut rotated by motor and speed reducer, automatically reversed. Steam pressure is maintained continuously during 8 hours' normal working day and closed down at night. Since early March, 1932, this double-end expansion joint has been under test and has been subjected to the equivalent of 20 years actual service. During this time readings at 30-min. intervals of conditions, including status of packing, have been taken.

Fig. 3—Detail of "gun," showing delivery of packing under pressure. Fig. 4 (inset)—Deflector vane delivers packing in clockwise direction and prevents backing up



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FREE-PISTON ENGINE COMPRESSOR

By J. GOULD COUTANT
Fuel Engineer

NOW coming into use in Europe is a new type of free-piston oil-engine air compressor without connecting rods, cranks, valves, spark plugs or flywheel. Its moving parts are in perfect balance. The inventor is the Marquis de Pescara, with headquarters in Paris.

Referring to the cross-sectional drawing, operation is as follows: The two opposed free pistons slide in and out in synchronism, insured by a lever pivoted at its center and connected by side rods to the two pistons. These rods do not normally transmit any power; their work is merely to absorb the slight incidental variations in the operation of the pistons and keep them in step. The oil pump, however, is operated by this mechanism.

In effect, the pistons are entirely free of mechanical connections and act as engine pistons on the inner ends and as compressors on the outer ends. All power is produced in space *C*, according to the diesel two-stroke cycle. Fuel oil is injected at *B* in proportion to load.

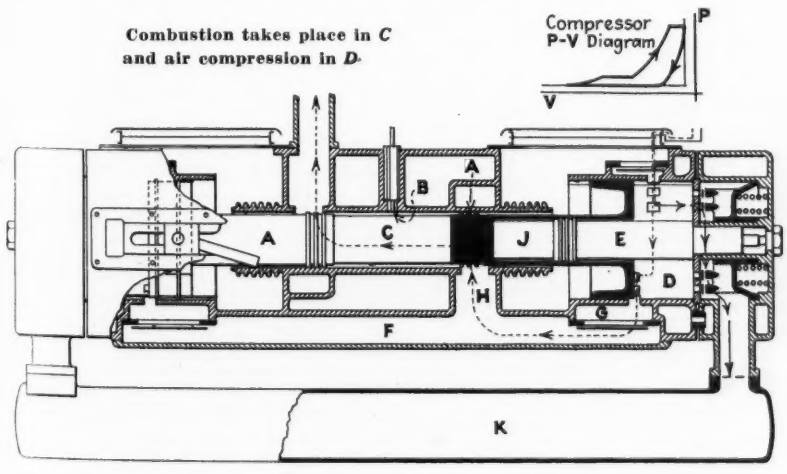
A coil spring (not shown) is cranked up for starting. The two pistons are driven together by the action of this spring. At the proper point explosion takes place and forces them out. This outward movement compresses air in the annular spaces *D*.

During the first stages of compression, part of the air is bypassed through the plate valve *G* and acts as scavenging air, passing through *H* into combustion space *C* and out through the exhaust. As the stroke continues, the bypass port is closed and the air pressure builds up for delivery to the receiver *K*, from which it passes to the outside application.

Compressed air locked in space *J* by the secondary fixed piston *E* acts as a cushion to insure return of the piston *A*, regardless of the load on the compressor ends. All of these actions, of course, take place simultaneously at both ends of the machine, which is symmetrical in all respects except for the location of the scavenging and exhaust ports.

The writer has operated three of these machines at the factory and believes them to be the simplest of prime movers.

Combustion takes place in *C* and air compression in *D*.



ON PAGE 197 of the October number of *Power* (Table of equipment—Cashman Laundry power plant) the second line under the heading "Miscellaneous" should read: "Feed water oil filter . . . *Blackburn-Smith Mfg. Co., Inc.*" On page 207, the letter headed "Blowing Soot from Regenerative Air Heaters," should be signed "H. S. Colby, *President, Air Preheater Corp.*"

Division of load between individual units is a vital factor in over-all steam-plant efficiency. This system of program load control automatically divides the load between several steam turbines according to a preset operating schedule to maintain highest station efficiency at all loads

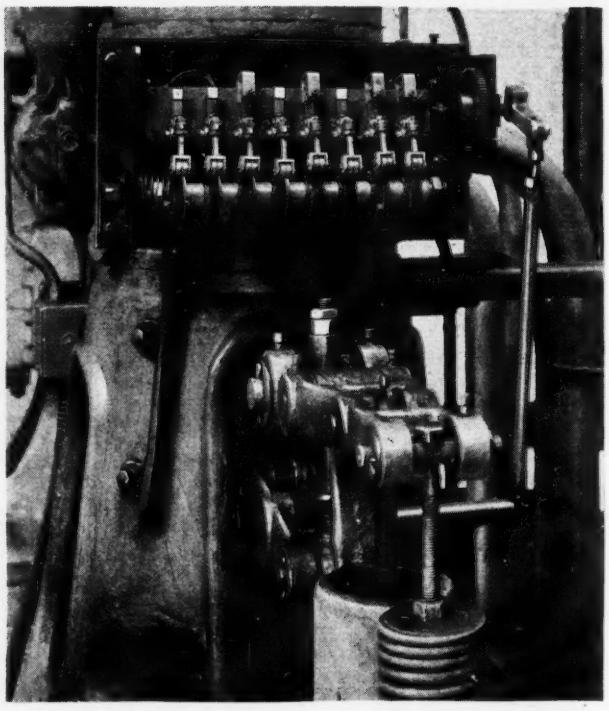


Fig. 1—Turbine-valve switches actuated by the governor mechanism to initiate the movement of the selector switch

Program Load Control IMPROVES STEAM ECONOMY

By A. P. HAYWARD and R. DECAMP

Engineer, Duquesne Light Co. *Switchboard Engineer, Westinghouse E. & M. Co.*

PROGRAM load control has been developed to improve the operating efficiency of groups of turbine-generators which must operate in parallel to supply a load that varies over the daily cycle. The application of automatic frequency or automatic load control in conjunction with program load control allows the use of the entire operating capacity of the station for regulation and maintains the minimum turbine heat consumption for all loads.

From a study made of several methods of load control a system was evolved that accurately follows a preset schedule. To show the difference in steam consumption with several methods of load division an example of a typical steam plant will be taken. The station in this case has six generating units: units 1 and 2 are rated 60,000 kw. each; units 3 and 4 are rated 35,000 kw. each; and units 5 and 6 have a capacity of 45,000 kw. each. The units are in identical pairs, and the station is one in which

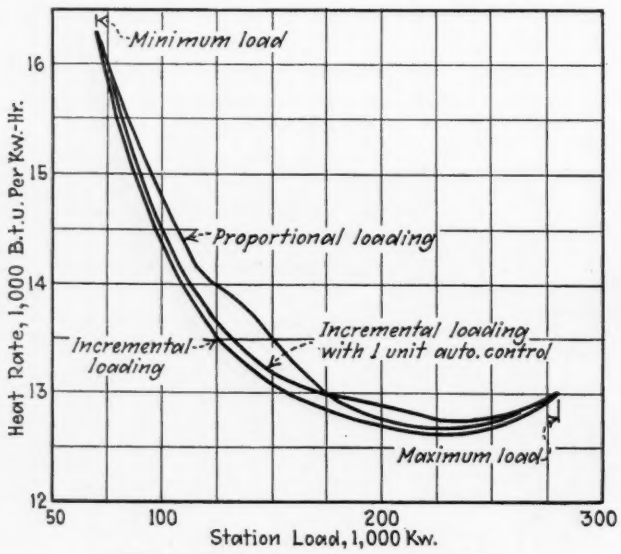


Fig. 4—Heat-rate curves for three different methods of loading the turbines.

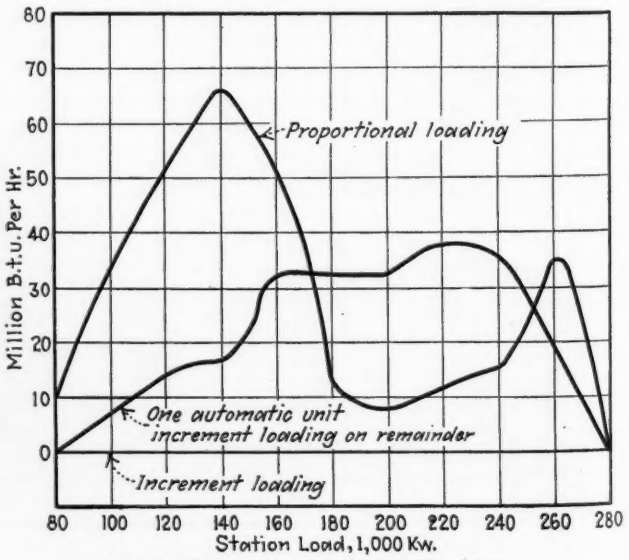
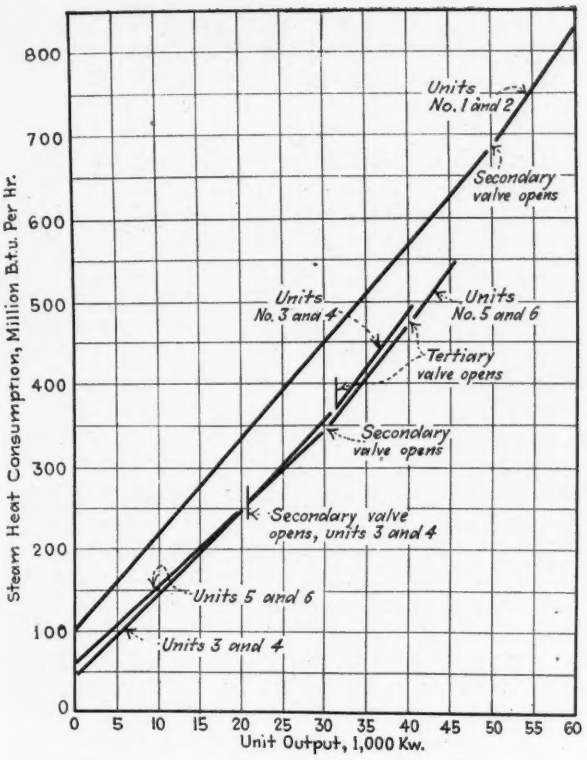


Fig. 5—Excess steam consumption above that required for incremental loading.



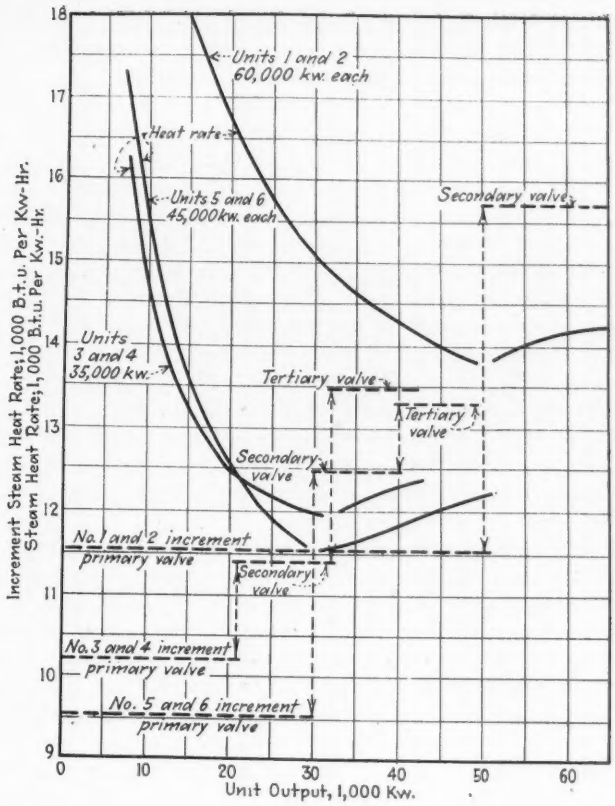


Fig. 2 (left)—Total hourly heat-consumption curves for the six turbines. Fig. 3—Steam-heat-rate and incremental curves for the turbines

the capacity has been gradually enlarged to meet increasing load demands.

The total heat consumption for all units, Fig. 2, gives heat rates as in Fig. 3. For these units the incremental heat rate is practically constant during the opening of a particular valve, thus the valve positions can be used to indicate the zones within which the incremental heat rates do not change. When loading by the incremental method all units are operated at the same incremental rate, or if this is not possible the units with the lowest incremental rates are loaded first.

With the turbines, the heat rates for which are shown in Fig. 3, there are no operating points where the incremental rates coincide except where duplicate units are operated on the same valves. Therefore, it is necessary first to load the low-incremental heat-rate units, adding load on one valve at a time in progression. A schedule or load program can be arranged as follows based on the increment heat rates, Fig. 3:

1. Unit 6 loaded to full primary valve.
2. Unit 5 loaded to full primary valve.
3. Unit 4 loaded to full primary valve.
4. Unit 3 loaded to full primary valve.
5. Unit 4 loaded to full secondary valve.
6. Unit 3 loaded to full secondary valve.
7. Unit 2 loaded to full primary valve.
8. Unit 1 loaded to full primary valve.
9. Unit 6 loaded to full secondary valve.
10. Unit 5 loaded to full secondary valve.
11. Unit 6 loaded to full tertiary valve.
12. Unit 5 loaded to full tertiary valve.
13. Unit 4 loaded to full tertiary valve.
14. Unit 3 loaded to full tertiary valve.
15. Unit 2 loaded to full secondary valve.
16. Unit 1 loaded to full secondary valve.

Since the units are in pairs and each pair has the same incremental rate over the same valve opening, the loading schedule may be arranged to load the units in pairs. The schedule under balanced pair operation would be:

1. Units 5 and 6 loaded to full primary valve.
2. Units 3 and 4 loaded to full primary valve.
3. Units 3 and 4 loaded to full secondary valve.
4. Units 1 and 2 loaded to full primary valve.
5. Units 5 and 6 loaded to full secondary valve.
6. Units 5 and 6 loaded to full tertiary valve.
7. Units 3 and 4 loaded to full tertiary valve.
8. Units 1 and 2 loaded to full secondary valve.

The combined heat rate for the six units of the station used as an example are shown in Fig. 4 based on the incremental loading schedules given previously. The heat rate is identical for single element of paired balance operation.

With a second method, known as proportional loading, each unit receives an amount of load increase in proportion to the unit capacity.

A third method of loading assigns one unit to carry load swings and, as the load builds up, the loads on the other units are increased in accordance with an incremental schedule. It is obvious that the regulating unit must have sufficient capacity to take care of the short-time load changes. From Fig. 4 it is evident that incremental loading produces a better heat rate over the entire load range than either of the other two methods. Fig. 5 gives the increase in heat consumption of methods 2 and 3 over incremental loading. Since the incremental loading method is simple and practical, a program load control has been developed to follow it automatically.

The equipment required for program load control may be divided into three parts: Valve auxiliary switches actuated by the governor mechanism, a motor-operated selector switch and a system of receptacles and jumper connections for presetting the desired schedule. A change in conditions within the station, such as generating units being out of service for maintenance or con-

denser sections out of service for cleaning, would call for a change in loading sequence. A simple and quick means for changing the loading schedule is essential.

The valve auxiliary switches initiate the movement of the selector switch and may therefore be considered as the "brains" of the program control. The switches should be of such a design as to permit continuous motion without excessive wear and to provide means for close adjustment. A cam-type switch meeting these requirements was designed and is shown in Fig. 1 installed on a turbine governor. The valve linkage causes an angular movement of approximately 40 deg., and gearing at one end of the cam switch multiplies this movement eight times. The cams are 4 in. in diameter, so that the small movement which would be represented by the cracking of a valve definitely operates one of the cam switches. Two contacts are provided for each valve, one making when the valve is fully open and the other breaking when the valve just opens.

The motor-operated selector switch is shown in Fig. 6. It has ten rows of contacts. Two of these rows control the selector-switch position, the contacts being energized from circuits through the jumper connection and presetting receptacles to the valve auxiliary switches. Two other rows of contacts are used for routing the raise and lower impulses from the regulator to the proper governor motor. The remaining six rows of contacts set up a combination of circuits through the valve and sequence receptacles and provide means to load the units in pairs. A contact-making wattmeter is connected to measure the difference in load of the two generators in a pair and makes one of two contacts depending on the load unbalance. A raise or lower impulse from the master regulator is thereby routed to the low or high machine respectively, and the load is thus balanced between units.

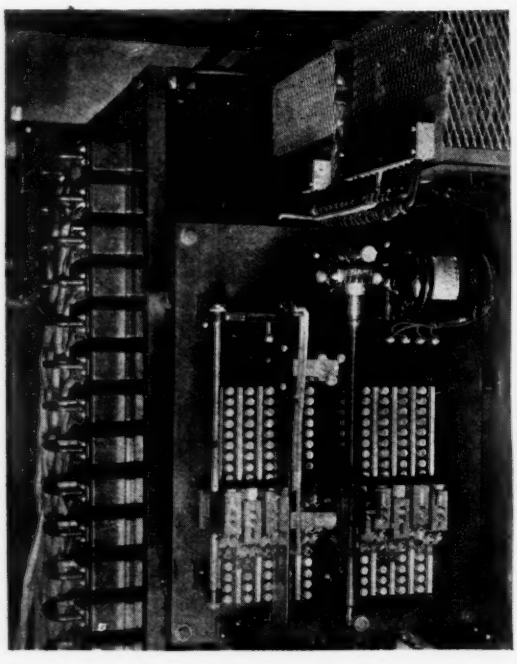
A preset feature is provided by a system of receptacles representing machine valves and sequence points. One row of sixteen receptacles represents the six turbine valves, and another row of sixteen receptacles represents the sixteen sequence points. Jumper connections with plugs on each end make it possible to set up all required loading schedules.

In operation, a raise or lower impulse from the master controller is routed through the plug board and motor-operated selector switch to the governor motor of one of the turbines. Consider a raise impulse and that the machine to which the impulses have been routed has just reached a wide-open primary valve, closing a contact on the cam switch. This raise impulse then energizes the motor-operated selector switch which travels to the next position and routes the raise impulse to the machine following in sequence, which, for example, has a full-open primary and secondary valve. Continued raise impulses will operate the governor motor on this machine until its tertiary valve is wide open, when a transfer action will again take place. Lowering impulses from the master controller are routed in the same manner.

Fig. 7 shows the program-load-control panels. The six control switches on the right-hand panel represent the six generating units. Each switch has three positions. In one position the unit is disconnected from the program control which will then omit it from the schedule. In the next position the program load control operates on the unit according to the preset load schedule. Three control switches on the left-hand panel are provided to set up the program control for balanced-pair operation. Two reset pushbuttons are provided to reset the selector switch to either the low or high limits. These reset pushbuttons allow the program load control to check the loads on all the operating machines by forcing the selector switch to travel to the row of contacts which control the first unit on the schedule. The first raise impulse will cause a transfer to the first unit not in a full-valve position. Continuation of the raise impulses will load this unit and transfer the selector to the next unit with a partial-valve load. If the trend is to reduce load, the selector is reset to the last unit on the schedule where it will check and unload the least efficient unit. This procedure is not necessary unless there have been manual adjustments off schedule, or transfers have occurred when there was a frequency error.

The lamp panel *L*, Fig. 7, gives indications of the valve positions and the direction and duration of the adjusting impulses to the governor on the unit under automatic control. The upper lamps in each group are energized from the same valve auxiliary switches that operate the selector switch, and the circuits are arranged so that light combinations indicate whether valves are closed, open or cracked. A red and a green lamp indicate raise or lower operation of the governor motor.

A program load control has been in operation at the Colfax station of the Dequesne Light Co. for about one year and has given satisfactory performance. Features of this installation are:



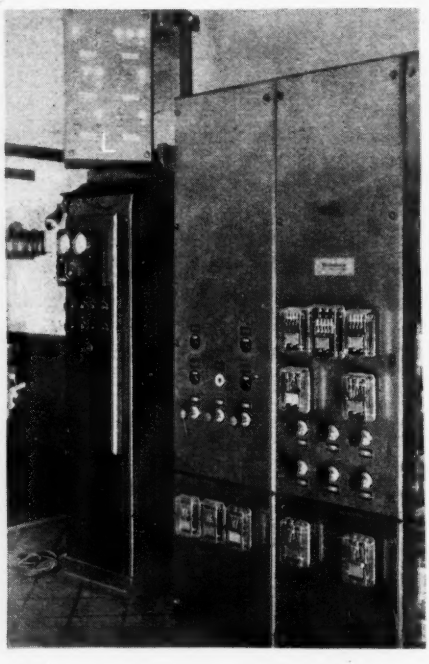


Fig. 6 (left) — Motor-operated selector switch for program load control. Fig. 7—Control panels for program-load-control system

1. Savings in operating expenses which justify cost of the equipment due to initiation by valve auxiliary switches, giving full-valve loads irrespective of variations in bleeding or vacuum; closer following of loading schedule than if control is left to the operator with consequent economy over manual load division; and reduction in valve maintenance due to transfer by valve position preventing operating at a valve cracking point.

2. Improvement in general operation due to safer overall operation, since operator does not give the loading his constant attention and more time is available to concentrate on switching setups, issuing clearances, etc.; availability of a practical device for steam plants, allowing application of automatic frequency or load control without sacrifice in economy; and provision of convenient means for changing the loading schedule if conditions change.

Program load control is applicable to power stations which do not operate at base load and must therefore follow system load changes. The effected economies of program load control are dependent upon the divergence in heat rate of the several units in the plant and also on the characteristics of the daily load cycle. Other benefits derived also must be taken into account.

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Synchronous Motor Earns One Thousand Dollars Yearly

By C. B. TALLEY
Engineer
Appalachian Electric Power Company

and H. W. FORSCHNER
Engineer
Electric Machinery Manufacturing Company

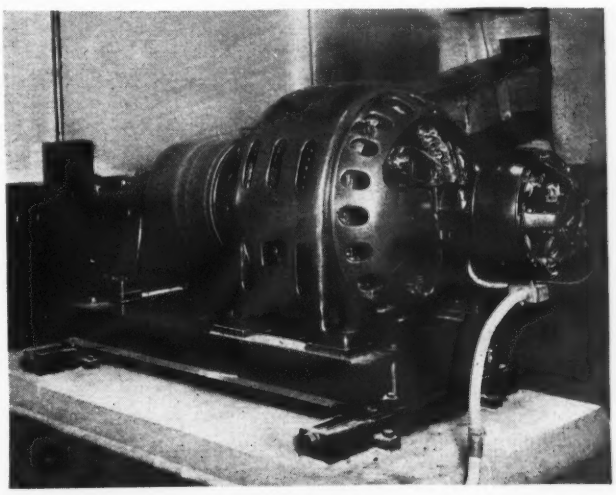
LOWER power costs give a welcome reduction in operating expense. How one company has accomplished a saving should be of interest to others, as the same general method can be used in many plants with varying amounts of savings, where there are suitable power-factor rates. The saving results from the fact that many power companies offer a lower power rate in return for the maintenance of a high plant power factor.

For several years the mill line-shaft at the Charleston Milling & Produce Co., Charleston, W. Va., had been driven by a slip-ring induction motor rated at 200 hp. Other smaller induction motors brought the total connected load to 867 hp. with an average plant power factor of 0.75.

For those users maintaining a high power factor, a substantial reduction in power costs is offered by the Appalachian Electric Power Co., which serves this mill. It was determined that a 0.8 leading power-factor synchronous motor of the same horsepower rating, to replace the slip-ring induction motor, would raise the plant power factor to approximately 0.99.

The synchronous motor was installed and the increase in power factor expected was obtained. An immediate reduction in power costs resulted. The power costs in April, 1931, for 88,800 kw. at 0.76 power factor was $1,207.07. In September of the same year when the synchronous motor was in operation the cost of 88,812 kw.-hr., with a power factor of 0.985, was $1,116.66 or a reduction of 1,207.07—1,116.66=$90.41. In May, 1931, the power factor was 0.765 and 84,000 kw.-hr. were used at a cost of $1,147.25. In October, the power factor was 0.99 with 84,011 kw.-hr. used at a cost of $1,063.16; a saving of $84.09. The months given were chosen because they furnish an almost exact comparison of power consumed, the earlier months with the induction motor and the later months with the synchronous motor.

The synchronous motor was arranged for mounting on the slide rails formerly used by the induction motor.



The rails were not moved from their original position in the foundation so that the exchange of motors was a relatively simple piece of work. The total cost for changing the motors was $3,000, allowing $200.00 from the sale of the induction motor.

It is seen that an investment of $3,000 brings a saving of over $1,000 yearly or a gross return of 33 per cent on the investment. At the end of three years the motor will have paid for itself and thereafter will continue to earn for its owner $1,000 yearly.

Further advantages in favor of this change are: New equipment replaces old equipment; higher efficiency of synchronous motor gives greater output at lower cost, aside from the saving made by power-factor correction; constant speed of synchronous motor assures maximum output and uniform product; automatic control enables starting of motor by merely pressing a button. Similar savings and advantages are available to many industrial plants and usually little effort is required to determine how they can be made.

By B. G. DICK
Mech. Eng.,
Portland Gas & Coke Co.

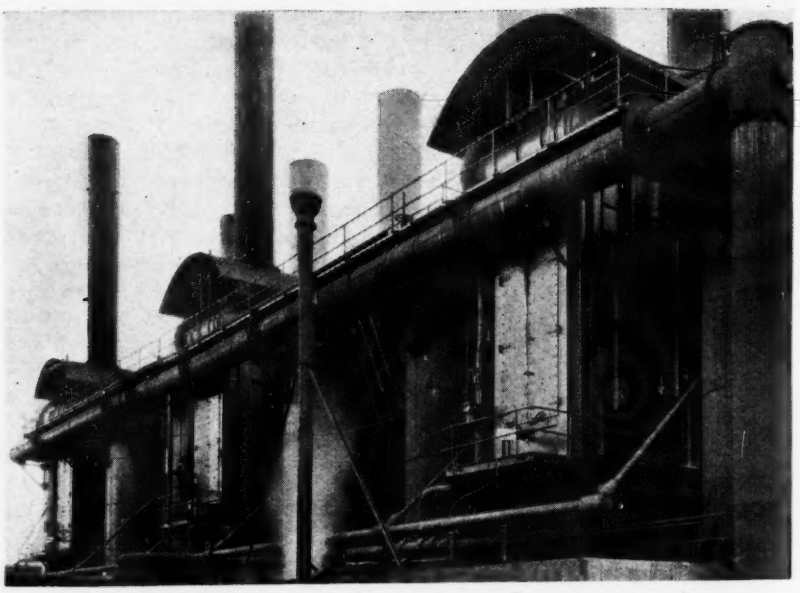


Fig. 1—Each of the three waste-heat boilers is located between two gas generators from which they receive hot gases

FEEDWATER REGULATION FOR VIOLENTLY FLUCTUATING LOADS

Feedwater control actuated by steam flow and water level, eliminated extreme high and low water, reduced fluctuation of feedwater demand, made steaming rate of the waste-heat boilers more uniform, thereby reducing fluctuation of load on power house boilers, and reduced routine duties of water tender

PORTLAND GAS & COKE CO., at its Gasco plant, manufactures gas from fuel oil with single-shell oil-gas generators. Three 6,000-sq.ft. boilers, designed to use waste heat from the oil-gas generators, generate steam for power and plant process purposes. Each boiler receives heat from two gas generators, the flow of heat from the generators to the boilers being controlled by hydraulically operated valves in the heat flues. The three waste-heat boilers generate approximately 70 per cent of the total steam used, while the remaining 30 per cent is generated by oil-fired power-house boilers.

Feedwater regulation due to the intermittent flow of heat through the boilers presented a rather difficult problem. The operating cycles on these generators are timed so that the heating periods do not occur at the same time, consequently the boiler receives heat from only one generator at a time. Ordinarily the individual generator operating cycle consists of a 12-min. heating period followed by a 24-min. interval before the heating period is again started. This cycle is sometimes changed to 15 min. heating followed by a 15-min. interval.

If the 12-24-min. generator cycle is used, heat flows through the boiler for 12 min. Then there is a 6-min. no-heat-flow period before the heating period of the second generator comes on the boiler. If the 15-15-min. cycle is used, generator heating periods are 15 min. with no interval between heating periods.

Regardless of which cycle is used the intensity of heat flow through the boilers varies between wide limits. The steam output of each waste-heat boiler increases from no delivery to 200 to 250 per cent of rating in seven minutes, and drops the load again in five minutes. The result of these rapid load changes is an equally rapid expansion or contraction of the entire body of the water in the boiler, resulting in an unavoidable level variation of approximately 4½ in. Fig. 2 shows operating curves for the waste-heat boiler.

Each boiler is equipped with a standard Copes feedwater regulator, consisting of a thermostat, which is the actuating element, and a balanced regulating valve which controls the flow of boiler feedwater. In operation this regulator feeds water in inverse proportion to the water level. The prompt expansion of boiler water when the load comes on reduces or stops feed flow, and the flow does not again begin until sufficient steam has been delivered to lower the level or until the load again recedes. In practice, the regulator has not reached the full open position when the load ends and the rapid contraction of water which accompanies termination of heat flow results in opening the regulator valve wider, thus increasing the supply of feed and further accentuating contraction of water within the boiler. Thus the operation of the simple level control regulator which is very effective and desirable in the normal boiler plant proved to be not fully effective on these waste-heat boilers.

Heavy demands for feedwater, caused by the rapid opening and closing of the feedwater valve, resulted in considerable feed-line pressure fluctuations. A differential pressure control valve was installed in the hope that elimination of these pressure differences would correct the difficulty. Trial of this valve disclosed that it performed its functions satisfactorily in maintaining a constant pressure drop across the control valve, but had little effect in correcting our difficulties.

A second effort to improve feedwater regulation was started by the development of a new series-type regulator. This regulator consists of a steam-flow thermostat complete with necessary levers, connecting rod and flow orifice, in combination with a standard Copes regulator.

In the diagram of the regulator, Fig. 3, the upper thermostat is influenced by the rate of steam flow in

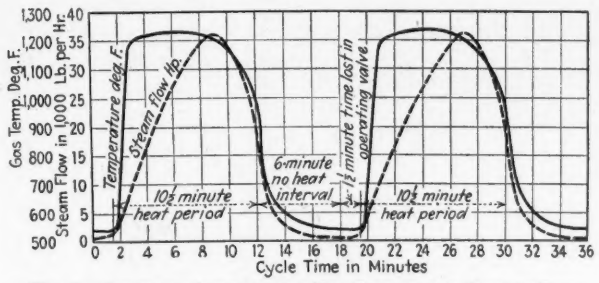

Gas Temp. Deg. F.
Steam Flow in 1000 Lb. per Hr.
Temperature deg. F.
Steam flow Hp.
6-minute no heat interval
½ minute time lost in operating valve
10½ minute heat period
10½ minute heat period
Cycle Time in Minutes

Fig. 2—Average steam generation from waste-heat boilers when generators operate on 12-24-min. cycle

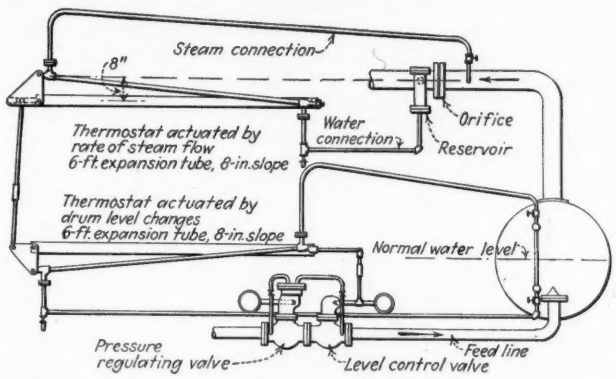


Fig. 3—Diagram of steam-flow water-level feedwater control

the main steam header; the lower by changes in boiler water level. Movement of either will operate the control valve. At no load, the steam thermostat is filled with water. As the load increases, the increased pressure drop across the orifice forces the water level down in the expansion tube. Steam enters the thermostat, expanding it, and opens the feed valve. As the load decreases the water level in the expansion tube rises, causing the tube to contract and close the feed valve.

If the water level in the boiler does not change, the entire valve operation is under the sole influence of the steam flow thermostat. It is only when boiler water level changes that there is any influence from the water-level compensating thermostat.

The series type regulator was installed on No. 9-10 waste-heat boiler and tests were made on April 29 and June 5, 1931. Data was taken on all three waste-heat boilers to show comparisons of feed-water regulation. The tests made on April 29 were with the gas generators operating on the 15-15-min. cycle and on the 12-24-min. cycle for the test made June 5. The test data showing: 1. Water levels in inches; 2. Control valve opening in percentage; 3. Steaming rates in points on steam flow meter indicator have been plotted against time readings at ½-min. intervals in Fig. 4 for the 12-24-min. operation.

Comparison of water level variations during the test periods shows a marked improvement in the control of feedwater to No. 9-10 boiler, and the danger of extreme high and low water has been eliminated. Minimum and maximum gage glass readings and total variation in water levels found on test are:

	15-15-Min. Cycle. Gage Readings, In.			12-24-Min. Cycle. Gage Readings, In.		
Boiler	Min.	Max.	Variation	Min.	Max.	Variation
* 7- 8 W. H. Boiler.....	0	6.25	6.25	0.20	14.00	13.80
9-10 W. H. Boiler.....	3.90	9.40	5.50	2.75	8.50	5.75
11-12 W. H. Boiler.....	2.75	13.25	10.50	0.10	10.15	10.65

*7-8 Boiler was operating on one generator during the 15-15-minute cycle test.

Intermittent flow of heat through the waste-heat boiler causes expansion and contraction of water within the boiler which in turn raises and lowers the water-gage levels. This variation in levels, which is estimated to be 3 to 4½ in., cannot be eliminated by the control valve. Considering that there will always be some water-level variation due to intermittent heat flow the 5¾-in. total variation shown on No. 9-10 boiler is good when compared to water level variations on No. 7-8 boiler.

First inspection of the curves in Fig. 4 shows the control valve operation of No. 9-10 boiler to be smoother and more regular than on boiler No. 7-8. The table below shows the position of water levels and the steaming rate for different control valve openings.

Control Valve	Water Level		Steaming Rate	
Position	Boiler 7-8	Boiler 9-10	Boiler 7-8	Boiler 9-10
Opening	Rapid drop to minimum	Gradual drop to average	Decreasing	Steady increase
Wide open	Minimum	Minimum	Minimum	Maximum
Closing	Rising, average to maximum	Gradual rise min. to max.	Rising	Decreasing
Closed	Maximum	Maximum	Maximum	Minimum

The important point shown in the above table is that boiler No. 9-10 with series type regulator takes feedwater during the steaming period or while heat is passing through the boiler. This tends to even out steam generation and so reduce the fluctuation of load on the power-house boilers.

Aside from greater safety in operation of No. 9-10 waste-heat boiler the series regulator is credited with tangible savings in boiler tending labor, power-house boiler fuel and increased feedwater temperatures.

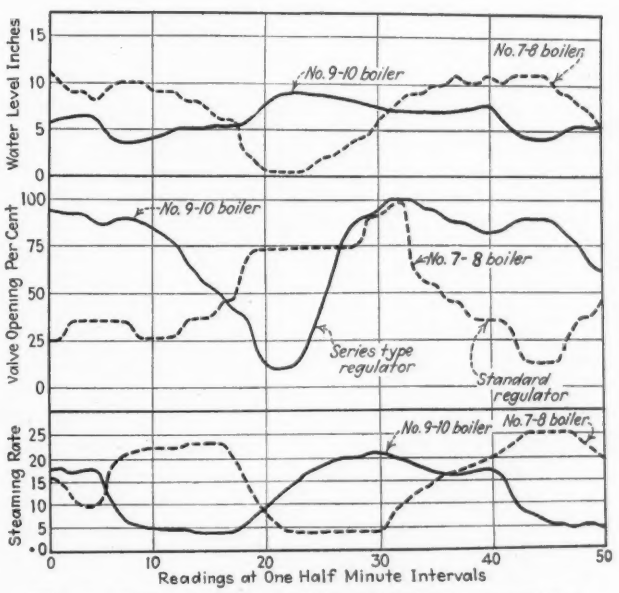


Fig. 4—Curves showing results of feedwater regulation tests when operating on 12-24-min. cycle

RULES OF THUMB FOR BYPRODUCT POWER

1. Allow ½ lb. coal per kw.-hr.

2. Or allow 5 lb. of steam per kw.-hr.

Precise steam table computations will give results so close to these in most cases, including power-plant cost-keeping, that the more refined calculations are a waste of time in figuring the steam cost of byproduct power

IN THESE days of "scientific precision," rule-of-thumb is under a cloud. In the power field, steam tables and their precise application have gained high standing. The ability to use them easily and correctly is the hall-mark of a sound technical training.

Speaking generally, this is all to the good. However, in displaying their new-found skill, some men fail to perceive that the ability to get along without these tables, and without elaborate computations, may at times indicate an even clearer conception of power processes. In short, there are places where scientifically grounded rules of thumb are entirely sufficient, and are actually superior to the "more precise" computations, because they do not obscure the main issues in a maze of figures.

For example, in figuring the effect of byproduct power production on coal consumption, engineers often take the long way round, with nothing worth while to show for their efforts. Let's compare.

Engineer *A* uses rule of thumb and says: "Byproduct power generation will cost me one-half pound coal per kilowatt-hour, regardless of the kind of boiler, kind of coal, pressure carried, efficiency of the engine and so on, provided only that all of the exhaust is needed and used for heating and process."

This looks too easy for Engineer *B*, who proceeds to get out his slide rule, steam tables, and Mollier chart. From the tables or chart he figures the adiabatic heat drop. Then, estimating the efficiency ratio of the engine, he computes the actual heat drop from which he gets the final quality of the exhaust steam (making another assumption regarding the amount of reheat available actually returned to the steam).

He computes the steam consumption and finds the steam flow required to carry a given kilowatt load. Then, estimating or computing boiler efficiency, he figures the extra coal required to put this extra heat into this much steam.

And when he is all through, what has he accomplished? He has obtained an answer so close to that of rule of thumb that the difference is less than the normal error of the measurements involved—too small to be of any practical importance.

Where the rule of thumb gives one-half pound of coal, the more refined computer may get 0.42 lb. per kilowatt-hour, or 0.58 lb., to take an extreme case. With coal at $5 per ton, the difference amounts to 0.02 cents per kilowatt-hour.

Such computations are sometimes made when deciding whether or not to generate byproduct power. Is it conceivable that a difference of this size would affect the decision? Again, is such precision of any practical value in power-cost accounting?

Let us look at this case another way. Assume that the plant contains a 200-kw. back-pressure turbine operating eight hours daily at an average load of 100 kw. The difference in coal consumption, figured by the two methods, would amount to 8 lb. per hour, or 64 lb. per day, costing 16 cents.

Now, everybody grants that the pennies are worth saving. On the other hand, it is obvious that any such "precision" applied to the daily fuel bill is practically meaningless.

It is quite safe, in computations of this type, to allow 5 lb. of steam "consumed" per kw.-hr. produced as a byproduct. In doing this one can be practically certain that the actual consumption will not vary more than one pound either way over the entire commercial range of prime mover efficiency and pressure.

This is perhaps an even better rule of thumb than that related to the coal consumption, since boiler and turbine rooms are usually kept apart in power cost keeping.

For example, if the process load is 10,000 lb. of steam per hour, and the kilowatts to be generated are 120, then power generation is equivalent to adding 5 x 120 = 600 lb. of steam per hour, or 6 per cent to the steam load. Actually, of course, the *weight* of steam generated may not be increased at all, but the pressure or temperature must be run up enough to allow for this 6 per cent increase in heat, and the coal consumption will likewise increase about 6 per cent.

The equivalent of 5 lb. of steam to 0.5 lb. coal is, of course, based on an evaporation of 10 lb. per pound of coal. It would take a variation from normal boiler efficiency of nearly 20 per cent to increase or decrease the coal per kilowatt-hour by 0.1 lb.

Generally steam costs are known. Since steam costs are invariably given in cents per thousand pounds, it may be convenient to remember that a kilowatt-hour of byproduct power consumes 0.005 of this standard unit of steam quantity. Then, if steam costs 30 cents per thousand, the steam cost of power is $0.005 \times 30 = 0.15$ cents per kilowatt-hour.

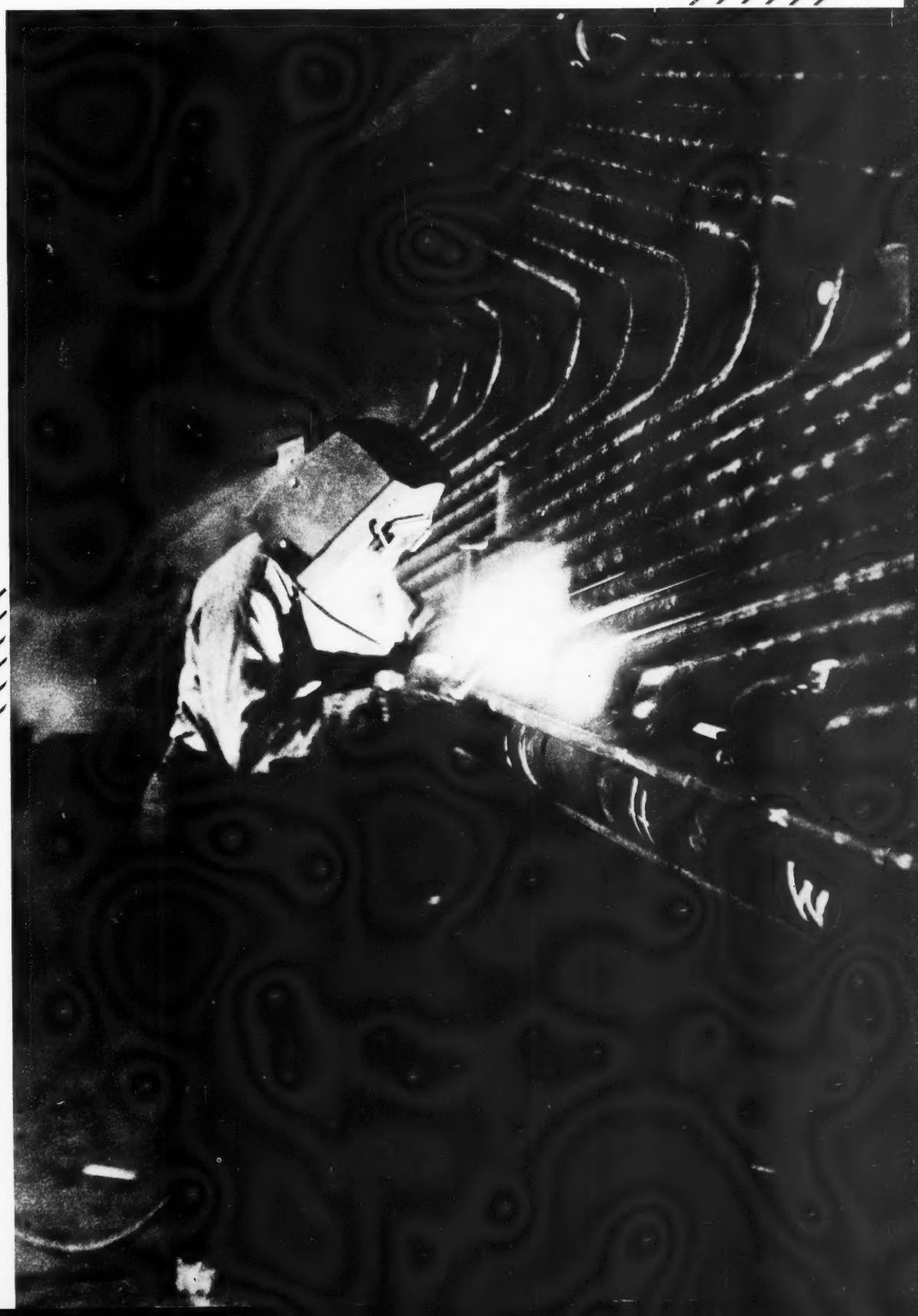
It is hard to imagine anything more simple, and the beauty of it is that the accuracy obtained by this simple rule of thumb is high enough for practically all engineering and accounting purposes, whether the unit actually passes 60 lb. of steam per kw.-hr., or 20, whether the initial pressure is 100 lb. or 600 lb.

Why, then, should it not be standard accounting practice to figure on this basis the steam chargeable to byproduct power generation? Subtract the steam so charged from the total generated to get the amount chargeable to heat and process.

Exit needless thermodynamics! Enter common sense!

HEAT Seals COLD

Welding, so widely used in the power field, is particularly suited to the fabrication of refrigerating equipment where tightness is of paramount importance.



Photograph courtesy of York Ice Machinery Corp.

TIDE WATER *Tests* 12

LONGER LIFE SHOWN

Revolutionary process extracts 16% impurities from 12 brands of turbine and Diesel oils . . . explains causes of instability

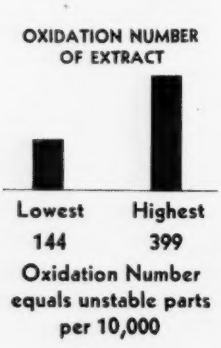
Why so much break-down in turbine and Diesel lubricating oils? Why so much sludge? Can they be eliminated? Will *modern* refining do it?

Tide Water made an exhaustive study of 12 competitive brands of oil . . . bought them in the open market . . . *re-refined* them by the Edeleanu Process, used by Tide Water.

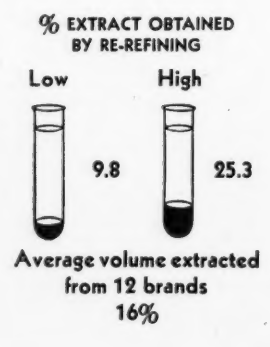
The average oxidation number of the oils before re-refining was 43; after re-refining, 5! The volume of impure oils extracted, ranged from 9.8% to 25.3% . . . an average of 16%! These extracts had oxidation numbers of 144 up to 399.

With such large percentages of the oils having tendencies to form sludge, acidity, and carbon . . . no wonder they are unstable and break down!

TESTS PROVE PROPER REFINING ESSENTIAL . . . **These findings show the causes of instability . . . they prove that proper refining is vital . . . and that Tide Water's Process produces an oil of maximum stability.**



Here are the reasons: The Process is a physical solvent treatment. It dissolves ALL unstable hydrocarbons, found even in the best of crudes. It starts NO chemical reaction upon the components of oil, stable or unstable. It forms NO new unstable substances. And it preserves the pure and stable hydrocarbons of highest lubricating value.



That is why Tycol Turbine and Diesel Oils, being 100% paraffine base, and refined by this Process, have purity and stability which no other oils possess. Tycol Oils have oxidation numbers ranging from 1/4 to 1/50 of those of competitive grades.

BE GUIDED BY SERVICE RECORDS . . . **In the final analysis, it is service that counts. Everything shown in these laboratory tests is borne out by experience. Tycol oils have set up new records of performance for some of the country's leading producers of power.**

Based on these records, you can depend on Tycol oils for low acidity, low carbon deposition and better demulsibility. You can depend on them for stability, for non-sludging, long-lasting, efficient, economical lubrication!

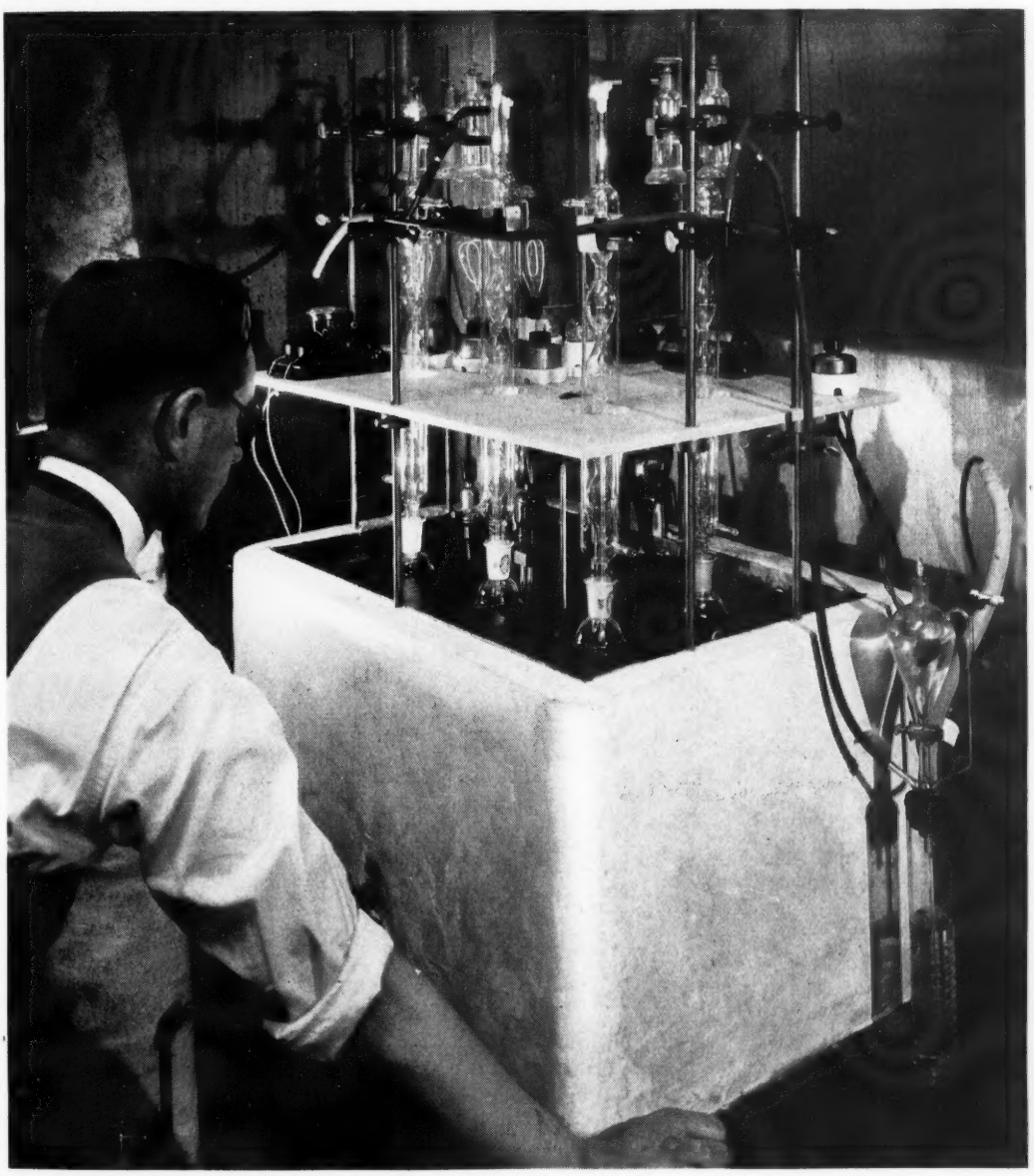
Write for the complete detailed Laboratory Report, "Re-refining 12 Brands of Oils." A copy of this booklet will be mailed upon request. Tide Water Oil Sales Corporation, 17 Battery Place, New York.

Competitive Oils by RE-*refining*

TO BE TYCOL FEATURE

KNOW YOUR OILS

So sure is Tide Water of Tycol superiority that it is making an unprecedented offer to buyers of turbine and Diesel oils. Tide Water will be glad to *re-refine for you,* by its Edeleanu Process, a sample of the turbine and Diesel lubricating oils you are now using. Not only that, Tide Water will welcome the presence of your own technologists, at the time.

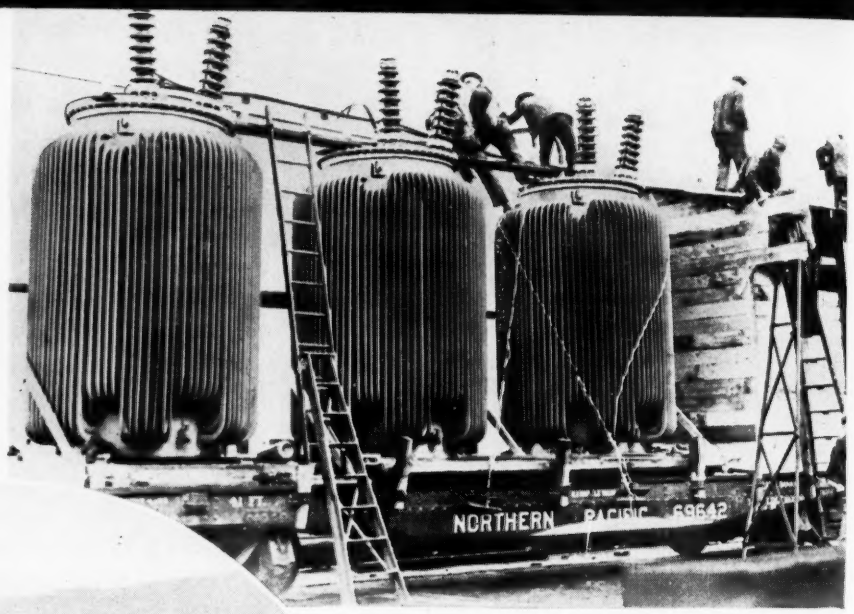


■ *Tide Water's Accelerated Stability Tester used in testing Tycol Diesel and Turbine Oils. Designed to impose even more rigid test conditions than obtained by any other device in common use.*

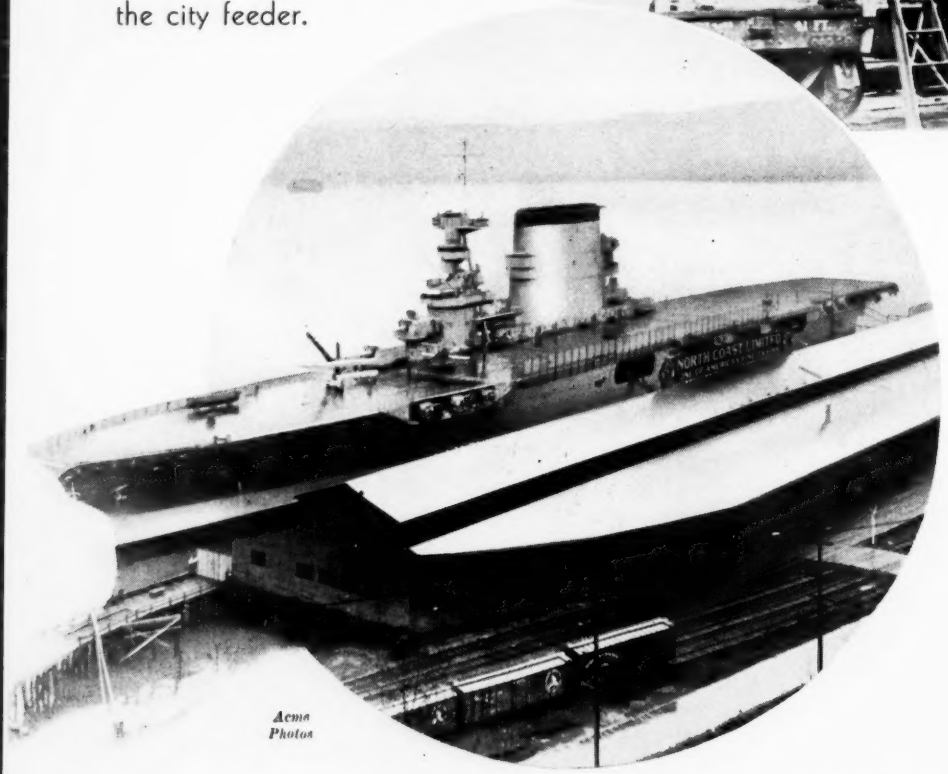
INDUSTRIAL TYCOL OILS-GREASES

TIDE WATER

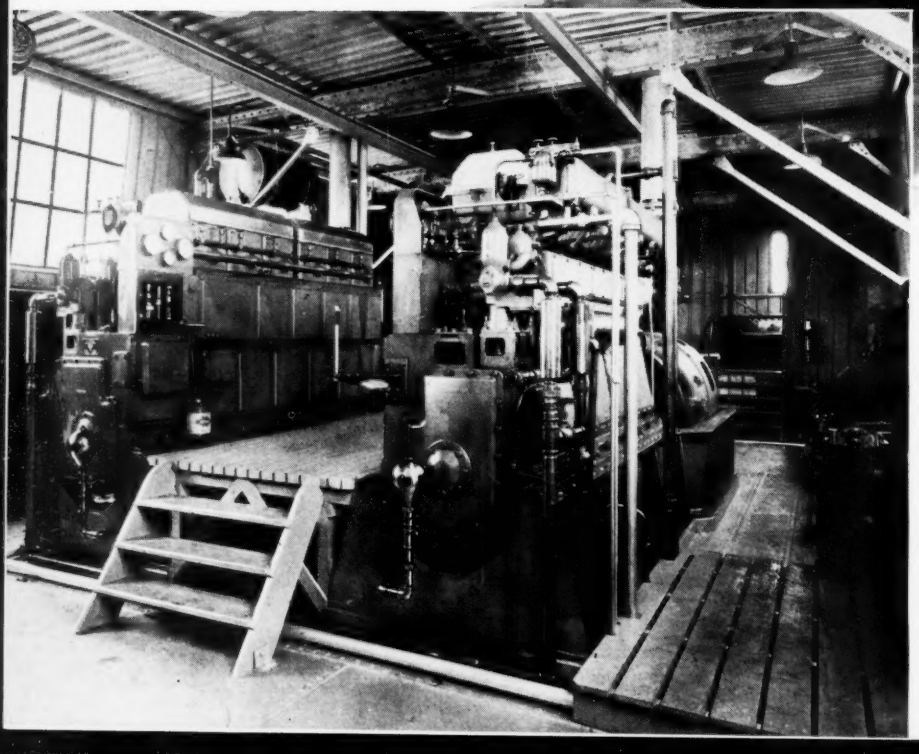
When Tacoma and Seattle, Wash., faced a power shortage due to drought in 1929, the U.S.S. Lexington came to the rescue. Transformers mounted on two flat cars stepped up her 4,600 volts to 50,000 for connection to the city feeder.



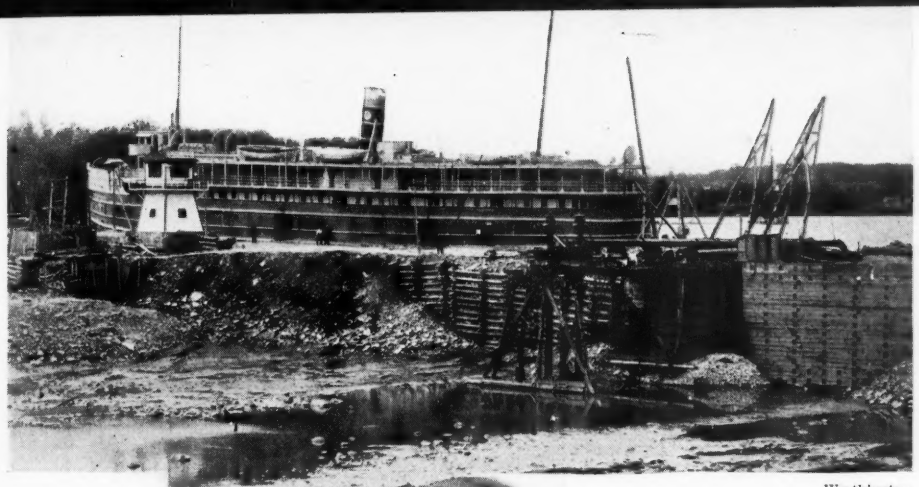
FLOATING



Acme Photos



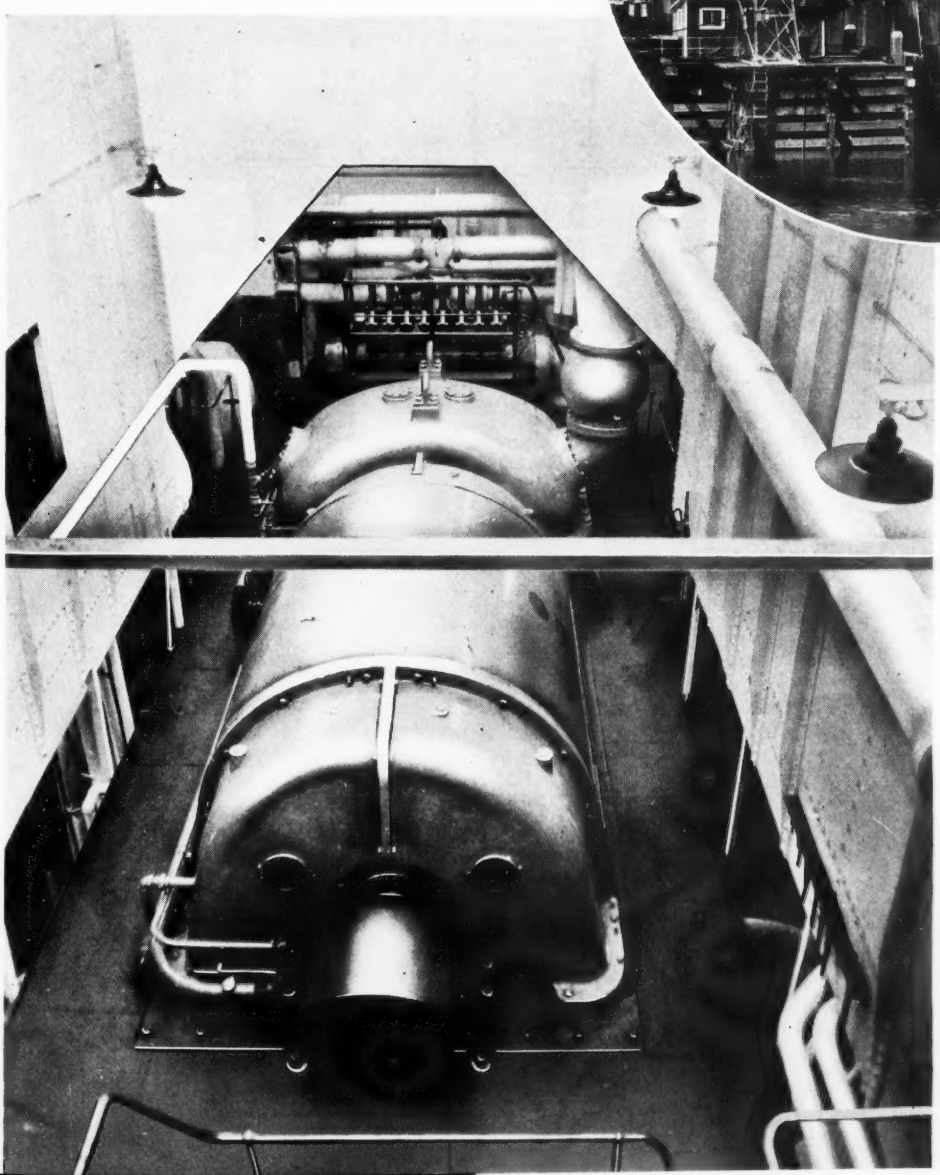
Extremely swampy conditions in southern Louisiana oil fields prompted Texas Co. to construct the steel barge "Energy" carrying two 500-hp. diesels. Normally, the "Energy" is moored at least 200 ft. from the well to avoid fire hazards.



Worthington

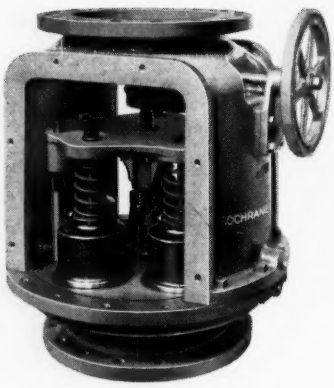
Floating power plants find constant service in river and harbor development. When West Neebish channel of St. Mary's River was deepened, Connolly Contracting Co. refitted the condemned "Indiana" as a power plant.

POWER



Public Service of New Hampshire operates the power ship "Jacona" to supply electrical power to shore stations in time of emergency. Four oil-burning boilers supply 280,000 lb. of steam per hr. at 425 lb. pressure to two 10,000-kw. turbo-generators. Complete equipment is carried.

COCHRANE
MULTIPORT VALVES

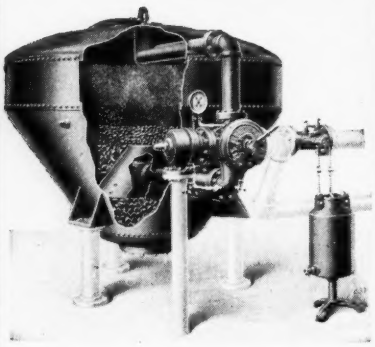


Silent . . . Safe Adjustable

NOISELESS release of excess exhaust steam is obtained by the use of a number of small valve disks instead of one large disk and by providing each disk with a vapor cushion chamber, which works equally well in superheated steam, air or wet steam. Each disk is loaded by an individual spring, the tension of all the springs being regulated by a single pressure plate adjustable up to a fixed limit. No possibility of overloading or tying down.

Ask for Publication L-1682.

COCHRANE
CONICAL FILTER



Purifies Oily Condensate

BY eliminating oily contamination from the condensed exhaust of engines, pumps, etc., valuable, pure, distilled water is recovered for boiler feeding, usually accompanied by a considerable saving in heat as well. The water is delivered crystal clear. The Cochrane Conical Filter has no distributing manifold or strainer valves to become clogged and is easily dumped and refilled with new filtering material, if desired. A single control valve, which replaces the five valves commonly used, facilitates back washing and makes the operation practically fool proof. A chemical feeder automatically proportions the coagulant.

Ask for Bulletin L-687.

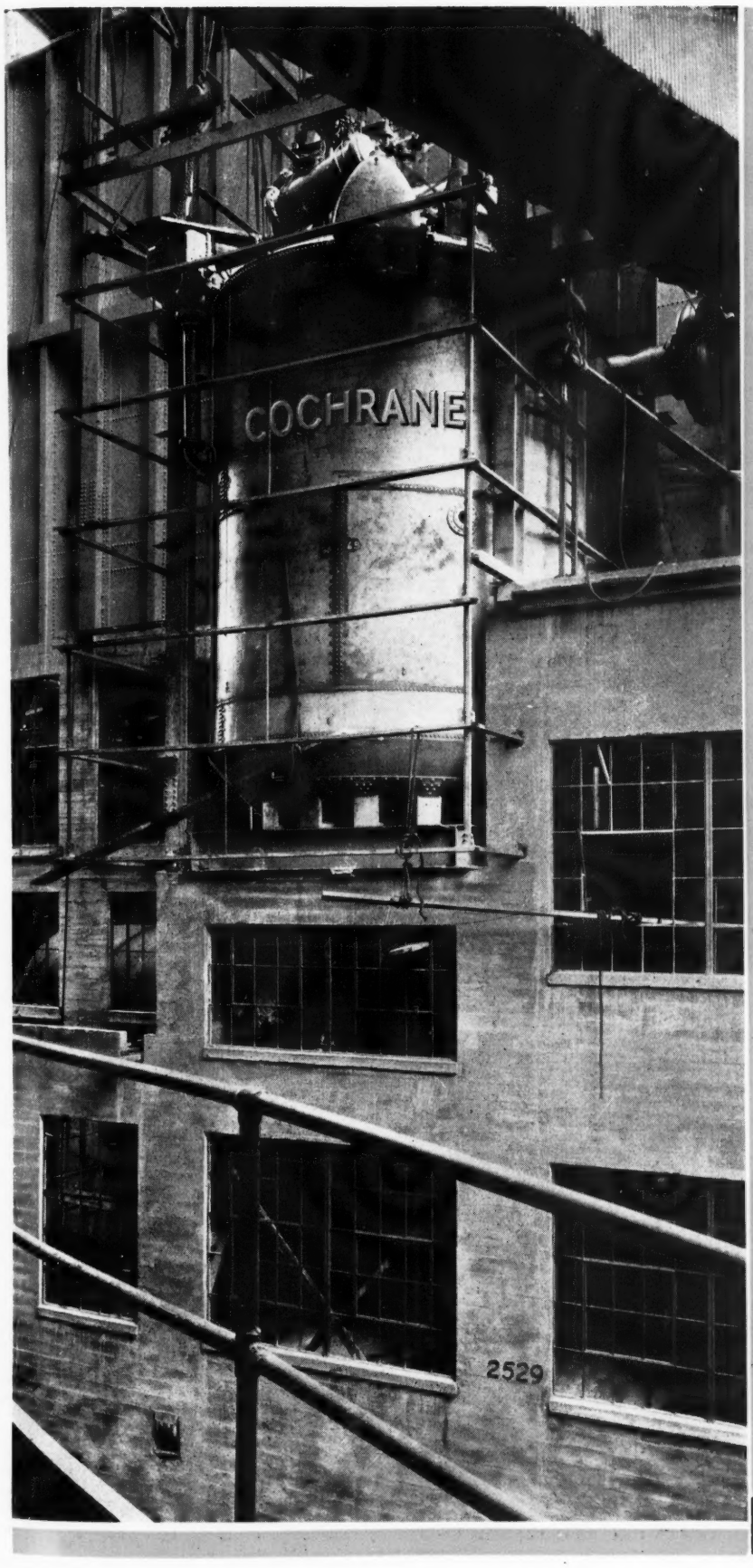
COCHRANE
CONTINUOUS BLOW-OFF SYSTEM

Saves Heat and Power, Combats Priming and Foaming

HOLDS the concentration of solids in the boiler water at the point which gives pure steam, while wasting the minimum amount of water and heat. Steam flashed from the blown-off water is recovered at high or low pressure for use in processes, and the remaining heat is transmitted to the cold feed water. The saving in heat alone will generally pay for the entire equipment in less than two years, and the uniformly good quality of the steam produced by the boilers insures the efficiency and safety of superheaters, engines and turbines.

Ask for Bulletin L-692

COCHRANE CORPORATION
17th & Clearfield Streets
PHILADELPHIA, PA.



32,000 gal. per hr. Cochrane Hot Process Softener treating make-up for 400 lb. boilers at Pennsylvania Sugar Company's plant, which is also equipped with Cochrane Continuous Blow-Off System, Cochrane Filters for removing oil from condensate, and Cochrane Multiport Back-pressure Valve.

A VERY UNUSUAL INSTALLATION *but* GOOD

FOR the comprehensive treatment of boiler feed, whether for treating a small percentage of make-up or for the entire boiler feed supply, the method of softening should give the greatest possible reduction in scale-forming matter, dissolved solids, dissolved oxygen, blow-down required and cost of chemicals, and should contribute to the thermal efficiency of the plant.

The COCHRANE HOT PROCESS SOFTENER obtains these results by using lime and soda ash (in some cases caustic soda) as the cheapest and most effective reagents, supplemented by phosphate for higher pressures (Hall System) and by utilizing exhaust or bled steam to preheat and deaerate the water. The apparatus for heating also deaerates. The chemical feeder proportions the milk of lime and other reagents accurately in fixed ratio to the flow of water. The reaction and sedimentation chamber removes sludge with a minimum waste of water. The filter can be backwashed without loss of heat and is not affected by hot alkaline water.

The Cochrane Continuous Blow-Off System holds the optimum concentration of boiler water, with least waste of water and heat.

Write for special literature on Water Conditioning.

COCHRANE CORPORATION
17th & Clearfield Streets
PHILADELPHIA, PA.

POWER'S DATA SHEETS

NUMBER 4

CAPACITIES OF CYLINDRICAL TANKS

TABLE I — CONTENTS OF CYLINDER PER IN. OF LENGTH

Dia. In.	Volume Cu.Ft.	Gal.	Lb. Water 60 Deg.	Dia. In.	Volume Cu.Ft.	Gal.	Lb. Water 60 Deg.	Dia. In.	Volume Cu.Ft.	Gal.	Lb. Water 60 Deg.	Dia. In.	Volume Cu.Ft.	Gal.	Lb. Water 60 Deg.	Dia. In.	Volume Cu.Ft.	Gal.	Lb. Water 60 Deg.
10	.04545	.3399	2.835	26	.3072	2.298	19.16	42	.8017	5.997	50.00	58	1.529	11.44	95.36	78	2.765	20.69	172.5
11	.05499	.4114	3.430	27	.3313	2.478	20.66	43	.8404	6.286	52.42	59	1.582	11.83	98.67	81	2.982	22.31	186.0
12	.06545	.4896	4.082	28	.3563	2.666	22.22	44	.8798	6.582	54.88	60	1.636	12.24	102.0	84	3.207	23.99	200.0
13	.07683	.5741	4.792	29	.3822	2.859	23.84	45	.9204	6.885	57.41	61	1.691	12.65	105.5	87	3.440	25.73	214.6
14	.08908	.6666	5.556	30	.4091	3.060	25.52	46	.9617	7.194	59.98	62	1.747	13.07	109.0	90	3.682	27.54	229.6
15	.1022	.7650	6.374	31	.4367	3.267	27.24	47	1.004	7.511	62.62	63	1.804	13.49	112.5	93	3.931	29.41	245.2
16	.1163	.8700	7.254	32	.4654	3.482	29.03	48	1.047	7.833	65.30	64	1.862	13.93	116.2	96	4.189	31.33	261.3
17	.1313	.9824	8.189	33	.4950	3.702	30.87	49	1.091	8.163	68.05	65	1.920	14.36	119.8	99	4.455	33.32	277.9
18	.1472	1.102	9.181	34	.5254	3.930	32.77	50	1.136	8.500	70.85	66	1.980	14.81	123.5	102	4.729	35.37	294.9
19	.1641	1.227	10.23	35	.5567	4.165	34.72	51	1.182	8.843	73.72	67	2.040	15.26	127.2	105	5.011	37.48	312.5
20	.1818	1.360	11.34	36	.5891	4.406	36.74	52	1.229	9.193	76.65	68	2.102	15.72	131.1	108	5.301	39.66	330.6
21	.2004	1.499	12.50	37	.6222	4.655	38.81	53	1.277	9.550	79.65	69	2.164	16.19	135.0	111	5.600	41.89	349.3
22	.2200	1.646	13.72	38	.6563	4.910	40.93	54	1.325	9.913	82.64	70	2.227	16.66	138.9	114	5.906	44.18	368.4
23	.2404	1.798	14.99	39	.6913	5.171	43.12	55	1.375	10.28	85.76	71	2.291	17.14	142.9	117	6.221	46.54	388.0
24	.2618	1.958	16.33	40	.7272	5.440	45.36	56	1.425	10.66	88.88	72	2.356	17.63	146.9	120	6.545	48.96	408.2
25	.2841	2.125	17.72	41	.7640	5.715	47.65	57	1.477	11.05	92.12	75	2.557	19.12	159.5				

TABLE II — LENGTH OF CYLINDER WITH VOLUME EQUAL TO ELLIPTICAL HEAD OF SAME DIAMETER

Depth of Head In.	Equivalent Cylinder In.	Depth of Head In.	Equivalent Cylinder In.	Depth of Head In.	Equivalent Cylinder In.	Depth of Head In.	Equivalent Cylinder In.
1	0.66	11	7.33	21	14	31	20.66
2	1.33	12	8	22	14.66	32	21.33
3	2	13	8.66	23	15.33	33	22
4	2.66	14	9.33	24	16	34	22.66
5	3.33	15	10	25	16.66	35	23.33
6	4	16	10.66	26	17.33	36	24
7	4.66	17	11.33	27	18	37	24.66
8	5.33	18	12	28	18.66	38	25.33
9	6	19	12.66	29	19.33	39	26
10	6.66	20	13.33	30	20	40	26.66

TABLE III — CAPACITY CONSTANTS FOR PARTLY FILLED HORIZONTAL CYLINDRICAL TANKS

Portion of Diam. at Liquid Level	Portion of Full Capacity	Portion of Diam. at Liquid Level	Portion of Full Capacity	Portion of Diam. at Liquid Level	Portion of Full Capacity	Portion of Diam. at Liquid Level	Portion of Full Capacity
.01	.0017	.26	.2066	.51	.5128	.76	.8155
.02	.0047	.27	.2179	.52	.5255	.77	.8263
.03	.0087	.28	.2292	.53	.5383	.78	.8369
.04	.0134	.29	.2407	.54	.5510	.79	.8474
.05	.0187	.30	.2523	.55	.5636	.80	.8576
.06	.0245	.31	.2640	.56	.5763	.81	.8677
.07	.0308	.32	.2759	.57	.5889	.82	.8776
.08	.0375	.33	.2878	.58	.6014	.83	.8873
.09	.0446	.34	.2998	.59	.6140	.84	.8967
.10	.0520	.35	.3119	.60	.6264	.85	.9059
.11	.0599	.36	.3241	.61	.6389	.86	.9149
.12	.0680	.37	.3364	.62	.6513	.87	.9236
.13	.0764	.38	.3487	.63	.6636	.88	.9320
.14	.0851	.39	.3611	.64	.6759	.89	.9401
.15	.0941	.40	.3736	.65	.6881	.90	.9480
.16	.1033	.41	.3860	.66	.7002	.91	.9554
.17	.1127	.42	.3986	.67	.7122	.92	.9625
.18	.1224	.43	.4111	.68	.7241	.93	.9692
.19	.1323	.44	.4237	.69	.7360	.94	.9755
.20	.1424	.45	.4364	.70	.7477	.95	.9813
.21	.1526	.46	.4490	.71	.7593	.96	.9866
.22	.1631	.47	.4617	.72	.7708	.97	.9913
.23	.1737	.48	.4745	.73	.7821	.98	.9952
.24	.1845	.49	.4872	.74	.7934	.99	.9983
.25	.1955	.50	.5000	.75	.8045	1.00	1.000

TABLE IV — CAPACITY CONSTANTS FOR PARTLY FILLED ELLIPTICAL HEADS

Fraction of Full Depth	Fraction of Full Capacity	Fraction of Full Depth	Fraction of Full Capacity	Fraction of Full Depth	Fraction of Full Capacity	Fraction of Full Depth	Fraction of Full Capacity
.01	.0003	.26	.168	.51	.517	.76	.853
.02	.001	.27	.179	.52	.530	.77	.865
.03	.003	.28	.190	.53	.545	.78	.875
.04	.005	.29	.202	.54	.560	.79	.885
.05	.007	.30	.216	.55	.574	.80	.896
.06	.011	.31	.228	.56	.590	.81	.905
.07	.014	.32	.241	.57	.604	.82	.913
.08	.019	.33	.256	.58	.619	.83	.922
.09	.023	.34	.270	.59	.633	.84	.930
.10	.028	.35	.282	.60	.648	.85	.939
.11	.033	.36	.297	.61	.662	.86	.945
.12	.039	.37	.310	.62	.674	.87	.953
.13	.046	.38	.324	.63	.688	.88	.960
.14	.052	.39	.338	.64	.702	.89	.966
.15	.060	.40	.352	.65	.715	.90	.972
.16	.069	.41	.368	.66	.729	.91	.977
.17	.077	.42	.382	.67	.742	.92	.982
.18	.086	.43	.398	.68	.756	.93	.986
.19	.095	.44	.412	.69	.769	.94	.989
.20	.104	.45	.428	.70	.784	.95	.993
.21	.114	.46	.441	.71	.797	.96	.995
.22	.124	.47	.457	.72	.808	.97	.997
.23	.135	.48	.471	.73	.820	.98	.998
.24	.146	.49	.487	.74	.831	.99	.999
.25	.156	.50	.500	.75	.844	1.00	1.00

To Determine Capacity of Flat-Ended Cylindrical Tank—Enter Table I opposite diameter, and multiply figure given there by tank length in inches. *Example:* Tank 72 in. in diam., 100 in. long. Volume, 235.6 cu.ft., containing 1,763 gal. or 14,690 lb.

Capacity of Elliptical-Ended Cylindrical Tank—Combine data in Table I as above with volume in heads from Table II. Thus, if the 72-in. diameter tank above had 18-in. elliptical heads, the equivalent length of cylinder for each head (Table II) is 12 in., making total length 124 in., volume (Table I) 292.1 cu.ft., 2,186 gal., or 18,215 lb. of water.

Content of Flat-Ended Horizontal Tank Partly Filled—Multiply capacity of tank by constants in Table III. Thus, if the horizontal cylindrical tank with flat ends above were 0.8 full, it would contain 0.8576 × 1,763 gal. = 1,511 gal.

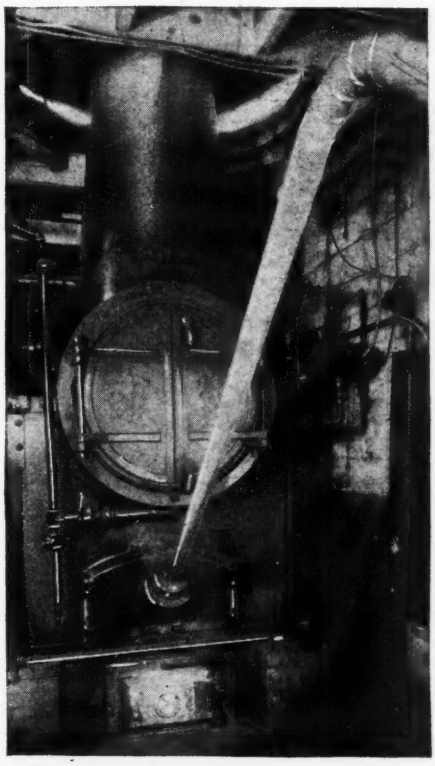
Content of Horizontal Elliptical-Ended Tank Partly Filled—Add to above answer fractional volume of *both* heads by multiplying full head volume by factor from Table IV. If one head is dished and other bumped, they cancel, and Table III alone is used.

Content of Vertical Tanks Partly Filled—Multiply capacity per inch (Table I) of flat-ended tank by number of inches filled. If bottom head is elliptical, add its content (Table II).

©Power

PLANT BUYS PULVERIZED COAL IN PAPER BAGS

By A. GRUENWALD



Pipe and burner replace the shovel at Redford Cleaning & Dyeing Co. plant

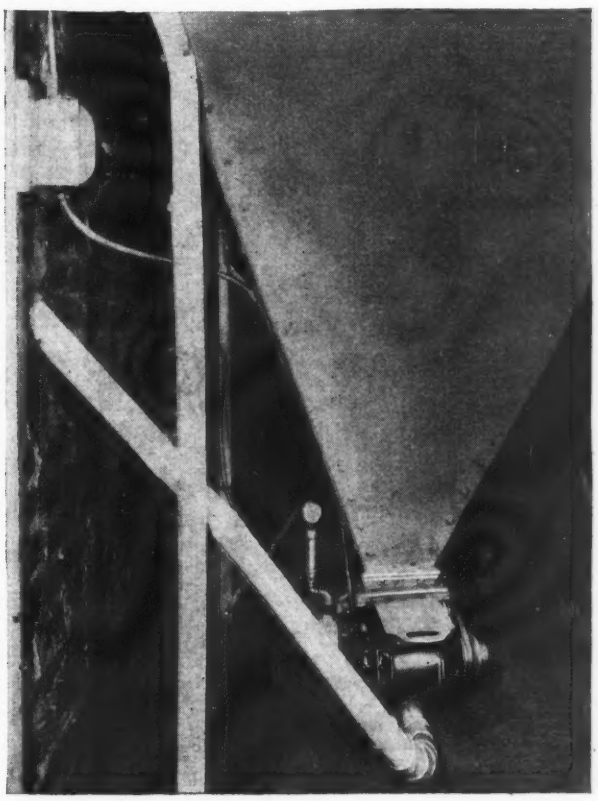
IN THE rapidly spreading application of pulverized fuel to plants of large and medium size, the field for this fuel in very small plants has been largerly overlooked. Thousands of small plants in the United States and Canada are burning coal under very poor conditions, and many are turning to oil for relief. For application in plants still burning small quantities of coal, E. Yoss has developed for the Automatic Pulverized Coal Co., Richmond, Va., a feeder of extremely simple design to be used with coal purchased in pulverized form.

The Yoss feeder consists of a small feeder wheel, a fan, and a coal supply bin. It is controlled by steam pressure through a mercury switch which shuts the feeder off when the steam pressure rises to its maximum, and starts the feeder when the steam pressure goes down to its minimum point. A pilot gas burner is also controlled by the mercury switch. This equipment can handle from 5 to 500 lb. of the pulverized coal per hour.

One of these Yoss feeders has been in operation at the Redford Cleaning & Dyeing Co., Richmond, since Nov. 1, 1931, and has shown its reliability by continuously operating without any interruption for mechanical defects.

In a 11½-hr. test, during which 550 lb. of coal was burned, an average over-all efficiency of 76.5 per cent was obtained.

The pulverized coal is delivered by truck in paper bags from the grinding plant, which is also controlled and owned by the Automatic Pulverized Coal Co. Arriving at the Redford Cleaning & Dyeing plant, the bags are dumped by hand into the storage hopper through a dust-proof fitting.



Bags of pulverized coal are dumped into a closed hopper over a simple feeder

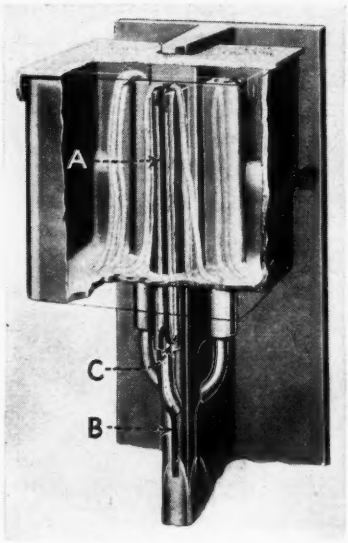
Fuel used for this type of service can be any bituminous coal mined in the United States or Canada.

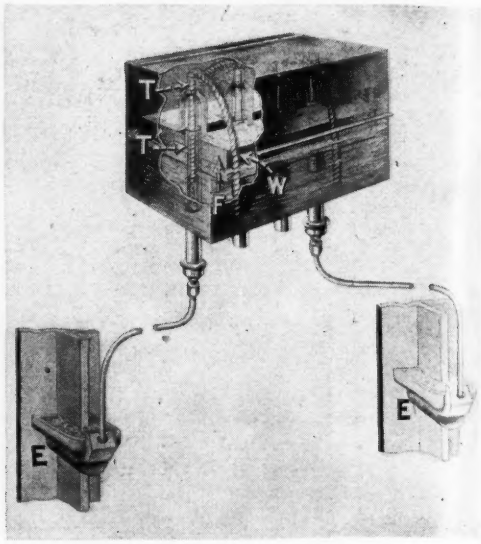
From the power field angle, this development is important because it opens up the possibilities of pulverized coal to innumerable very small boiler plants that would normally operate on solid fuel without pulverization, or turn—as many have—to oil firing.

Equipment of Redford Cleaning & Dyeing Co. plant

Boiler	400-sq.ft. "Economic" combination fire-tube boiler built by the Erie City Boiler Works
Feeder	Yoss Feeder, Model 100-A
Motors	2-¼ hp. Century motors, one on the feeder and one on the fan
Feedwater system	Kisco Automatic Return System
Mercury Switch	General Electric
Stack	18 in. x 60 ft.

Automatic lubrication of elevator guide rails under the difficult conditions imposed by high-rise, high-speed cars operated to meet exacting service demands of modern buildings offers a number of difficult problems. Only careful consideration of the types of equipment available will result in satisfactory lubrication





AUTOMATIC LUBRICATORS REPLACE

LUBRICATION of guide rails is the most difficult problem connected with passenger- and freight-elevator operation. The lubricated surfaces of the rails are exposed and collect dust and dirt blown about by the car as it passes up and down the hoistway. In modern high buildings the rails may be 1,000 ft. or more in length, with cars operating at speeds up to 1,200 ft. per min. High rises and high speed add materially to the difficulties of maintaining a good film of lubricant on the rail surfaces.

If the oil film becomes too thin or broken, the guide shoes will bite the rails and cause noise and unpleasant riding of the car. Wear of the guide shoes, power consumption for the elevator's operation and maintenance costs will increase. When there is an excess of lubricant on the rails it is thrown off by the guide shoes onto the car and into the bottom of the hoistway. If oil gets on the car it is likely to work inside of the cab and cause stains, or worse, get on passengers' clothing. In addition it creates a dirty condition in the hoistway and adds to the difficulties of keeping the place clean.

The old method of lubricating guide rails is to paint them with a heavy oil or grease periodically, the operation being performed by an attendant riding on top of the car. Lubrication of guide rails by hand is about the most hazardous and disagreeable job in the maintenance of elevators. Not only are the services of two men required to do the job, one to operate the car and another to ride on top and do the greasing, but the elevator must be taken out of service while the work is done. For these reasons, where lubricating is done by hand it is frequently neglected.

Another objection to hand greasing is that the rails either have a feast or a famine of lubricant. There is generally too much grease on the rails when the lubricating is completed. After the elevator has operated awhile there is a deficiency of lubrication, and the rails may not be greased again until attention is called to the need by the guide shoes seizing the rails.

In an attempt to overcome these difficulties, automatic lubrication of guide rails has come into general use. Automatic lubrication of guide rails is by no means a simple problem, as evidenced by the large number of devices that have been developed for this work. Some of these have been satisfactory on low-rise slow-speed cars and failed to meet the requirements of high speed and high rises. Others have not been entirely satisfactory for other reasons. There are several types available that give satisfactory operation if used for the conditions for which they are suited.

Lubricants ranging in consistency from light oil to solid greases are used in automatic lubricators. One of the advantages claimed for light oils is that they tend to run down the rail and wash the dust and dirt off. On the other hand, at high speeds they are more likely to be thrown off the rails by the guide shoes. This difficulty can be at least partly overcome by chamfering the top and bottom edges of the guide-shoe gibs, so as to form receptacles for the oil. Greases, although they adhere to the rails better than oils, have the corresponding disadvantage of holding any dirt that may be deposited on the rails.

Automatic guide-rail lubricators are made in two general types, those that are stationary and are mounted at the top of the hoistway and those that are located on the car and counterweights and travel with them. The stationary types generally use oil as the lubricant.

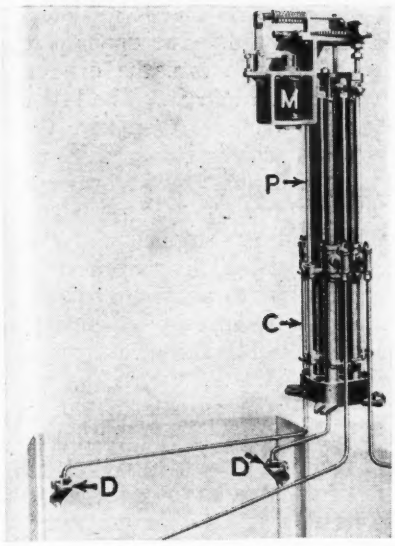


Fig. 1 (Left)—Wick-type stationary lubricator. Fig. 2 (Center)—Reservoir-type stationary lubricator. Fig. 3 (Right)—Positive-type stationary lubricator

GREASE POTS AND SWABS

Since they are mounted at the upper end of the guide rail it is necessary that the oil be of the right consistency to run down the rail and assist the guide shoes in its distribution.

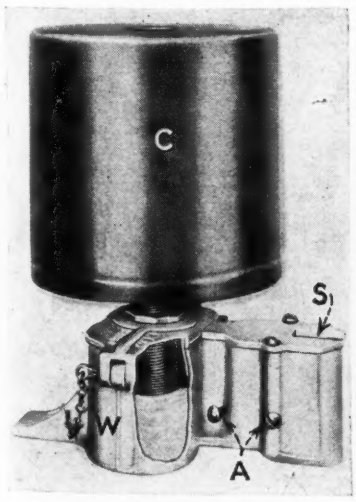
One type of stationary lubricator is shown in Fig. 1. It consists of a reservoir from which oil is fed continuously by three wicks to three sides of the guide rails. A spring *A* passes down the center of a tube and comes out on the guide rail as indicated at *B*, there being three tubes, one for each side of the rail. About halfway down each spring is a loop *C*, through which the wick passes and doubles back into the oil in the reservoir. The amount of oil fed to the guide rails is controlled by the number of wicks looped through the springs.

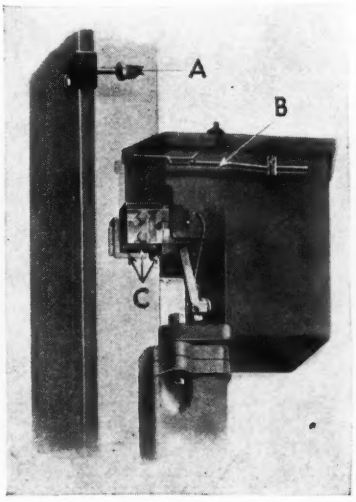
One of the most desirable locations for these lubricators is on the top ends of the guide rails when they have been extended up into the pent house. If not installed in this manner they may be mounted on a short section of guide rail in the elevator-machine room and the lubricating tubes extended down to the top ends of the guide rails.

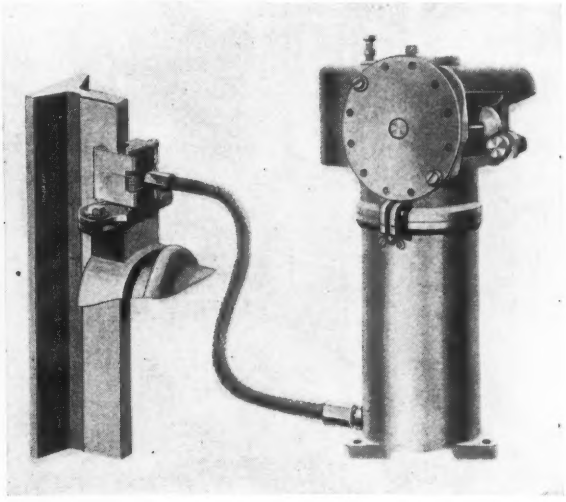
A type of stationary lubricator using a common reservoir for the four guide rails is shown in Fig. 2. Oil is fed from the reservoir by capillary action of wicks *W* that dip into the oil and pass into the conveyor tubes that lead to a U-shaped element *E* fastened near the top end of each guide rail. These elements have three wicks that distribute the oil evenly to the three sides of the rails. To maintain a constant oil feed from the reservoir to the guide rails, the capillary elements are mounted on a float *F* that rises and falls with the oil level in the reservoir. The wicks lead into tubes *T* supported on the float. These tubes telescope into tubes *T'* with a clearance that allows a free movement of the float. Since the float maintains practically a constant length of wick in the oil at all levels of the lubricant, the capillary action is constant and oil feed uniform. Adjustment of rate of oil feed can be made by raising or lowering tubes *T*, which are held in their supporting brackets by setscrews.

The two types of lubricators just described supply oil to the guide rails when the car is not in operation just as when it is in service. This may be objectionable if the car is shut down for long periods. Fig. 3 shows a type of lubricator that feeds to the rails only when the car is in operation. This device is electrically operated, is placed in the pent house and as a unit automatically lubricates the four guide rails. Oil contained in four cylinders, one for each guide rail, is forced out by the downward motion of pistons *P*. After being forced out of the cylinders the oil flows by gravity through tubes to the distributors *D*, which deliver it to the three surfaces of the rails. Magnet *M* is energized by the car closing a hoistway switch or by a contact on the

Fig. 4 (Left)—Siphon-type traveling lubricator. Fig. 5 (Center)—Positive-type traveling lubricator. Fig. 6 (Right)—Inertia-type traveling lubricator







selector switch. When this coil is energized it works a ratchet that turns a threaded shaft to lower the plungers into the cylinders. The stroke of the plungers is adjustable so that the amount of oil delivered to the guide rails each time the magnet switch is closed can be made proportional to the installation's requirements.

Several traveling types of automatic lubricators are mounted on the car and counterweight guide shoes. One of these, operating on a siphon principle, is shown in Fig. 4. This lubricator is designed to apply a heavy oil uniformly to the guide rails. A nipple threaded through the cover of the oil well *W* supports the oil container *C*. By turning the container the lower end of the nipple is raised or lowered into the oil well and the oil level thus adjusted to obtain the proper feed to the rail for satisfactory lubrication.

The lubricator is supported on top of the guide shoe so that the guide rail passes through the slot *S*. A felt wiper contacts the rail on three sides and siphons the oil from the well and distributes it on the rail's surfaces. Oil is fed to the rails only when the car is in motion. Any wear on the felt wipers may be taken off by turning adjusting screws *A*.

Another type of lubricator for applying a heavy oil to the guide rails is shown in Fig. 5. The oil is fed from a reservoir by a mechanically operated pump. The lubricator is mounted on top of the car or counterweight guide shoes. As the car starts from the terminal floor, lever *B* strikes a contact arm *A*, fastened to the guide rail, and causes the lever to move downward. This action operates the plunger of a pump in the oil reservoir and a charge of lubricant is delivered to an auxiliary reservoir from which it drips to fiber distributing blocks *C*. These are held in contact with the rail, and spread the oil uniformly as the car travels up and down the hoistway. A heavy oil is used in this type of lubricator and the quantity may be adjusted to suit the service conditions. The type of lubricator shown in Fig. 6 operates on the inertia principle and is designed to apply a grease to the guide rails. The gun, which will develop approximately 40-lb. gage pressure, forces a special grease out through a flexible tube to a distributor mounted directly above the guide shoe.

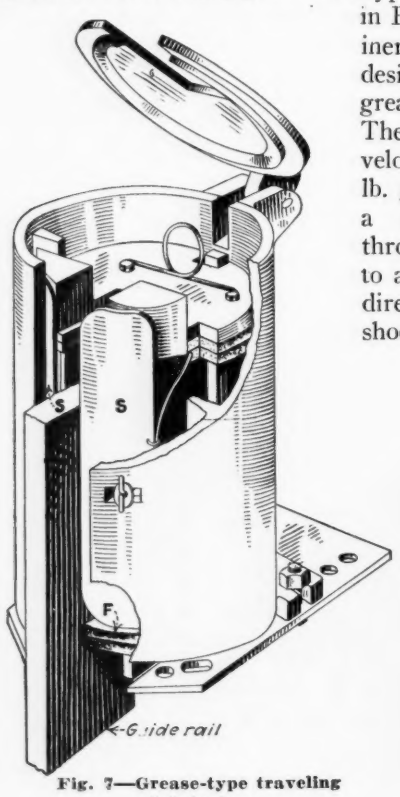


Fig. 7—Grease-type traveling lubricator

The lubricator consists of two parts and is mounted on the car or counterweight crosshead. The upper part comprises a housing with a movable cap, the driving mechanism and a piston with its feed shaft. The lower part is a grease container of proper size to receive the piston. The weighted lubricator cap is balanced by an adjustable spiral spring, so that it floats on its bearings sensitive to changes in acceleration.

When the elevator is started or stopped the cap rocks up and down from its inertia. This movement is transmitted in a positive direction to a driving wheel. The wheel in turning drives a worm shaft which is geared to the piston's feed shaft. The distance through which the lubricator's cap can swing each time the car starts and stops is controlled by an adjustable buffer, which permits regulating grease to the guide rail.

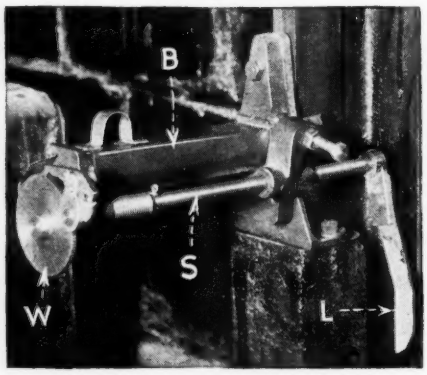
In the design in Fig. 7, the guide rail passes through the grease reservoir, which is mounted on the guide shoe. The bottom of the reservoir is sealed to the guide rail by a felt pad *F*. On top of the grease is a weighted pad. The front of the reservoir is sealed to the guide rail with two spring-actuated fiber shutters *S*. Recommended for use in these lubricators is a light-weight grease which is packed in the reservoirs around the guide rails and is applied to them by movement of the car and counterweights. Lubricant is applied only when the car is in motion, the action being much the same as if the grease were applied by a soft brush rubbing on the rail.

The lubricator in Fig. 8 is of the force-feed type and uses a special high-grade grease in stick form. The grease stick is put into the barrel *B* and is forced out onto the rail by a metal block that is pushed ahead by a feed screw. The grease is applied to the rail by a fiber shoe that is supported in a pivoted carrier. A wheel *W* on one end of the feed screw is turned by a ratchet through the motion of shaft *S*, upon which is supported operating lever *L*. A small cam is mounted at the top or bottom end of the guide rail. The car approaching the end of travel comes in contact with the operating lever, and moves the ratchet wheel and feed screw to supply a small amount of lubricant to the guide rail. The amount of grease fed to the guide rail may be regulated by an adjusting screw to limit the throw of the operating lever.

The guide-rail lubricators described in the foregoing do not include all the designs that have been developed and used. They are, however, representative of the different principles that have been employed in that class of equipment.

Acknowledgment is hereby made for assistance in the preparation of this article to the Atlas Elevator Devices Company, New York City; Albert Johnson, Victoria Building, New York City; Otis Elevator Company, New York City; Elevator Supplies Co., Inc., Hoboken, N. J.; Westinghouse Electric Elevator Company, Chicago, Ill.; Yvan Zenon, Rosedale, N. Y.; and Bowman Agency, Inc., Arlington, N. J.

Fig. 8—Positive-feed-type grease lubricator



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How Anthracite Coal Burns

By R. S. JULSRUD
Industrial Engineer
Anthracite Institute

Efficient combustion of anthracite coal depends upon an understanding of the combustion principles involved. This article traces the combustion process through three stages — distillation, oxidation and reduction — and shows the need of providing overfire air

ANTHRACITE burns with a short blue flame, gives off very little odor, does not soften or cake when burned, gives off practically no smoke, and when in a state of incandescence emits considerable radiant energy. It is characterized by few joints and clefts and their squareness, its relative hardness and density, and specific gravity ranging from 1.40 to 1.80.

The fusing temperature of most anthracite ash varies between 2,600 and 3,000 deg. F., the average approaching the higher fusing value. The standard anthracite sizing specifications for steam sizes, as adopted and approved by the Anthracite Institute, are shown in Table I.

Table I — Standard Anthracite Specifications

Size	Test Mesh — Through, In.	Test Mesh — Over, In.	Per Cent Oversize, Max.	Per Cent Undersize, Max.	Per Cent Undersize, Min.
Buckwheat	9/16	5/16	10	15	7½
Rice	5/16	3/16	10	15	7½
Barley	3/16	3/32	10	20	10
No. 4 Buck	3/32	3/64	..	..	..

The proximate analyses of several typical Pennsylvania anthracites are shown in Table II.

Table II — Analyses of Several Pennsylvania Anthracites

County	Size	Per Cent Moisture	Per Cent Volatile Matter	Per Cent Fixed Carbon	Per Cent Ash	B.t.u. per Lb.
Dauphin	No. 1 Buck	2.15	12.88	78.23	8.92	13,140
Luzerne	No. 2 Buck	1.25	8.18	79.61	12.21	12,400
Schuylkill	No. 1 Buck	0.55	4.30	86.73	12.72	12,642
Carbon	No. 1 Buck	1.57	5.27	80.90	14.20	12,800
Lackawanna	No. 1 Buck	4.0	5.60	81.30	13.70	12,985

Theoretical air requirements for the combustion of 1 lb. of anthracite are approximately 11.50 lb. Generally 50 per cent or more excess air is necessary to secure complete combustion, so that about 15 lb. at least of air will be supplied to burn 1 lb. of anthracite.

When a fresh charge of anthracite is placed in a furnace it is not immediately converted to its ultimate products of CO_2 and H_2O regardless of its size or the method of firing. Immediately after its introduction to the furnace it absorbs heat, driving off the surface and inherent moisture. This is practically completed at temperatures below 400 deg.

As the charge continues to absorb heat, the volatile matter, consisting of hydrocarbons, CO and H_2, distill off, leaving solid carbon and incombustible ash on the grate. The latter, of course, does not participate in the combustion process. The distillation of volatile matter begins at about 550 deg. F. and is practically complete at 1,000 deg., the hydrocarbons evolving first, followed by hydrogen and CO at the higher temperatures. The carbon or coke remaining on the grate is partly burned to CO_2, the remainder burning to CO, which in turn is oxidized to CO_2, provided air is available above the fuel bed.

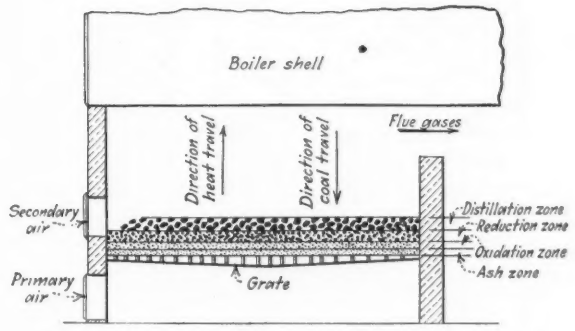


Fig. 1—Combustion zones in an anthracite fuel bed

The sequence of these chemical changes in the fuel bed, though very rapid, is by the following definite stages following the introduction of the charge to the furnace: (1) evolution of the combined and inherent moisture in the fuel, (2) distillation of the volatile matter and (3) partial combustion of the coke. Above the fuel bed, combustion of the volatile matter (methane, hydrogen, carbon monoxide, etc.) takes place, as well as the partial combustion to CO of the residue coke in the fuel bed.

Actually, very little of the coke burns to CO_2 on the grate. When carbon dioxide comes in contact with incandescent carbon in its passage through the fuel bed, it is reduced to CO again. As a result about 50 per cent of the heat in the charge is developed in the fuel bed and 50 per cent in the gases above the fuel bed.

In the combustion of any coal, three distinct reactions take place, namely: oxidation of carbon to CO_2, the reduction of CO_2 to CO and distillation of the volatile matter. This latter reaction is important in the burning of anthracite since it explains the almost complete absence of smoke from this fuel. In visualizing this combustion process, it would be well to consider it the result of two streams flowing in opposite directions, that is, the air passing upward, the fuel downward as shown in Fig. 1

The air coming up through the fuel bed is called *primary* air; that admitted over the fuel bed to consume the distilled gases is known as *secondary* air. Since these distilled gases represent about 50 per cent of the total heat in the fuel, the presence of secondary air over the fuel bed is important. In the oxidation zone of the fuel bed, the coke is first burned to CO_2 by the primary air passing up through the fuel. The CO_2 then travels upward through the incandescent coke and is partially reduced to CO in the reduction zone. The distillation zone consists of fresh fuel, which is here separated into volatile gases and free coke. The rate

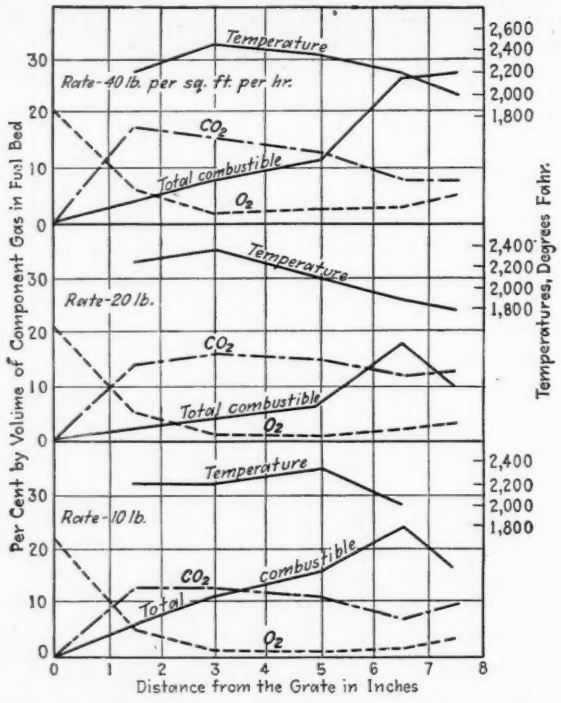


Fig. 2—Combustion of anthracite in a 6 in. fuel bed. Note that oxygen and combustible gases combine rapidly to form CO_2. Nearly all the oxygen is consumed within 3 in. above the grate

of distillation of these gases from the green fuel depends on the temperature in this zone alone.

Extensive and elaborate series of tests to study the combustion reactions in coal-fired furnaces have been made by the U. S. Bureau of Mines. In these tests, made on Pennsylvania anthracite, the combustion rates varied from 3 to 125 lb. of fuel per sq.ft. of grate surface per hr., and two thicknesses of fuel bed (6 and 12 in.) were used.

The results of analyzing the gases at varying distances from the grate and plotting the percentage of each component in the gas against the distance above the grate when burning Pennsylvania anthracite is shown in Fig. 2.

This curve represents the composite results of burning rates varying from 10 to 40 lb. per sq.ft. of grate with a 6-in. fuel bed as commonly met in practice.

From these tests the following conclusions may be drawn: (1) the O_2 supplied with the primary air beneath the grates is all used in oxidizing the carbon in the fuel to CO_2 in the first 4 in. above the grate; (2) very little CO is formed until the O_2 is practically all consumed. Thereafter it forms at a rapid rate simultaneous with the reduction of CO_2 by the incandescent coke. The thicker the fuel bed the more CO is formed: (3) Increasing the amount and velocity of the primary air supplied results only in increased rates of burning of the fuel, provided no blowholes or clinkers are present; (4) the temperature in the fuel bed varies from approximately 2,000 to 2,500 deg. F., the higher temperatures being obtained with higher firing rates per square foot of grate area.

The fuel bed is then in reality a gas producer. Since the purpose is to burn the combustible to CO_2, the fuel bed should be no thicker than necessary to prevent blowholes, in order to secure best results.

From this data it is evident that, for an evenly distributed fuel presenting uniform resistance to the passage of the primary air through it, secondary air should be provided over the fuel bed to consume the combustible gases distilled from the solid fuel. The ideal method of admitting this secondary air is in thin streams as close as possible to the distilled gases, and utilizing the balance of the combustion space for mixing and burning them. Complete and efficient combustion therefore involves: (1) correct proportioning of the air at the right point and (2) thorough mixing of the air and combustible gases.

The combustible gases arising from the fuel bed surface consist of hydrocarbons, CO and H_2, as in Fig. 3.

When burning anthracite, these gases are largely of CO and H_2, with small amounts of hydrocarbons, due to the low volatile content of this fuel. Then, as secondary air is admitted, these gases react under ordinary combustion condition to form: $2\ CO + O_2 = 2\ CO_2$ and $2\ H_2 + O_2 = 2\ H_2O$. Since both CO and H react rapidly with free O_2 when supplied at or above their ignition temperatures the combustion of anthracite is practically complete within short distances from the fuel

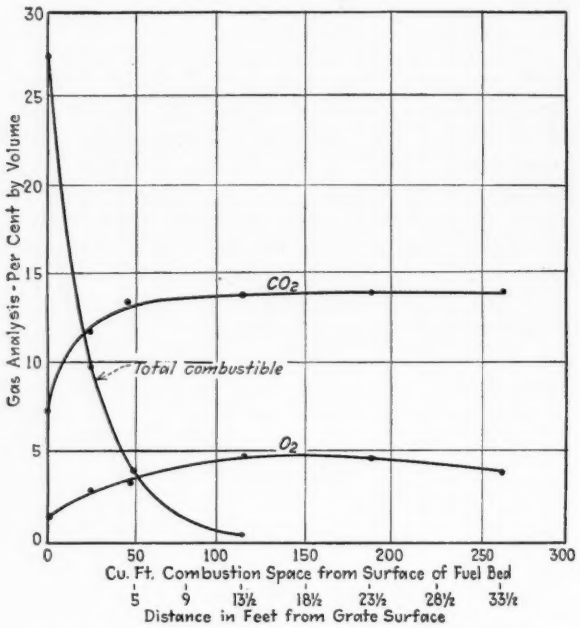

CO_2
Total combustible
O_2
Gas Analysis - Per Cent by Volume
Cu. Ft. Combustion Space from Surface of Fuel Bed
Distance in Feet from Grate Surface

Fig. 3—Combustion of furnace gases above fuel bed of Pittsburgh screenings burning at the rate of 35 lb. per sq.ft. per hr.

bed. This is readily verified by observing the rapid change of the blue colored flame into clear orange-colored flame and absence of smoke indicative of complete combustion in an anthracite fired furnace.

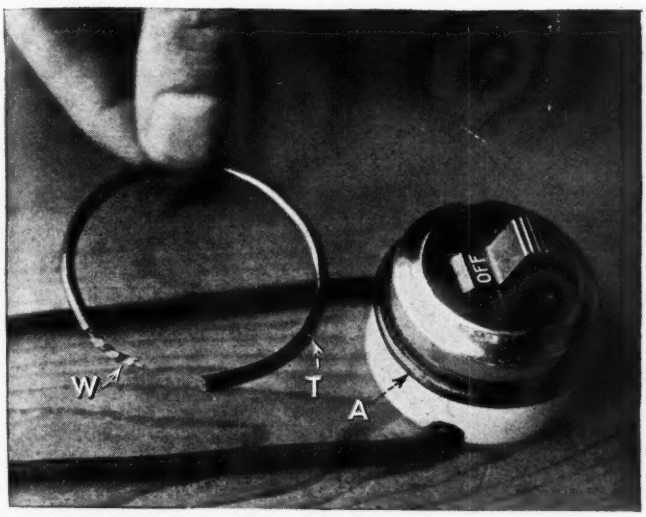
The combustion of anthracite, whether on grates or stokers, verifies the following conclusions: (1) The gases arising from the fuel bed consisting mostly of CO and H_2 combines rapidly with the free O_2 present in the combustion chamber to form CO_2 and water vapor; (2) this rapid reaction results in high heat release in the combustion chamber; (3) lower boiler settings can be used with anthracite than with fuels containing large quantities of volatile hydrocarbons.

In common with other solid fuels burned on grates, anthracite, in an evenly distributed fuel bed, must be supplied with secondary air. This may be done through regulated air openings above the fuel bed or through unregulated air leaks in the boiler setting, fire doors, etc., and through blowholes in the fuel bed. The latter method is generally wasteful and should be corrected.

PRACTICAL AIDS TO OPERATION

Neat Method of Marking Special Light Switches

A SWITCH controlling a red light or other special caution circuit is frequently located close to other switches of the same kind, and it is best plainly to mark or designate it in some special manner. One way of doing this is by a sign or card, which is often not a convenient or handy



method. Instead, I use a piece of red spaghetti insulating tubing, *T*, cut the right length to go around the switch. Inside the tubing is placed a piece of stiff wire *W*. The combination can be fitted and placed snugly over some part of the switch, as at *A*, where it is plainly seen from any angle. This clearly and safely marks a particular switch. This tubing comes in all colors, and can be used to designate a switch controlling any color of light or light circuits.

Missouri Valley, Iowa. FRANK W. BENTLEY

Scale in Feed-Water Pipe Caused Error in Meter Reading

IN A plant where the feed-water meter was the only means of obtaining a check on the amount of steam used by the turbines driving the generators, it was discovered that steam consumption had been gradually increasing for some time. The turbines were overhauled, switchboard meters checked and other expedients tried in an effort to locate the cause of the apparent increase in steam used. Finally it was decided to take down the section of feed-water pipe in which the pitot tube for the meter was connected. Inside this pipe, which was 4 in. in diameter, was found a layer of scale about $\frac{1}{8}$ in. thick. As the thickness of this scale increased, the velocity of the water was also increased, and caused the meter to give a higher reading than normal.

After the pipe was cleaned the steam consumption of the turbines was again found to be normal.

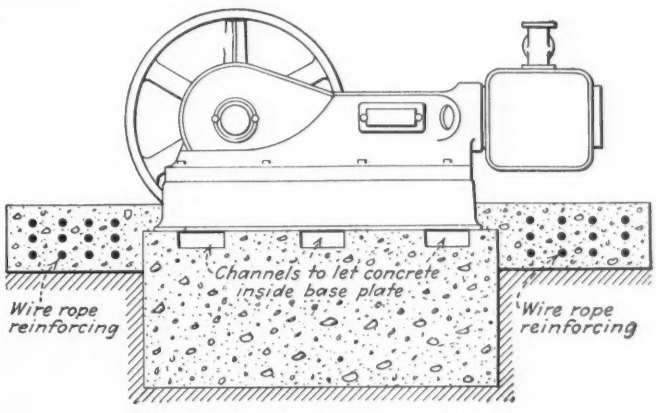
The effects of a thin layer of scale on the inside of a pipe is shown in this case, for although the scale was only about $\frac{1}{8}$ in. thick it reduced the inside cross-sectional area of the pipe about 12 per cent and increased the rate of flow by an equal amount. When using any type of flow meter it is advisable to calibrate the meter occasionally and to clean the section of pipe used for measuring.

Westfield, N. J. GORDON R. HAHN.

Engine Tightened to Foundation With Reinforced Concrete

THE method of tightening an engine, loose for several years, to its foundation may be of interest. A bedplate on the foundation supported the engine, as indicated in the figure. The bedplate moved on the foundation about $\frac{3}{8}$ in. on each stroke of the engine. If it had any holding-down bolts, they were on the inside and could not be tightened without dismantling the engine. As the engine had to be kept in operation each week from Monday morning until Saturday noon, it could not be shut down long enough to take it off the base to tighten the bedplate bolts. It was therefore decided to anchor the bedplate to the foundation with reinforced concrete.

This operation consisted of digging away from around the foundation about 12 in. deep and 4 ft. wide. The depth was as far as it was considered safe to go without danger of loosening the foundation. Three channels about 4 in. deep by 10 in. wide were cut in the founda-



tion's top so that concrete could be worked up inside the bedplate. When this was done and the form made for the concrete, the engine was shut down one Saturday at noon and leveled and aligned with its generator by driving steel wedges between the bedplate and foundation.

Concrete was then poured around the foundation about 18 in. deep and 4 ft. wide, as shown in the figure. This concrete was reinforced with old wire rope that was available around the plant. The concrete was poured

in layers about 3 in. thick, with several turns of the rope around the foundation between layers.

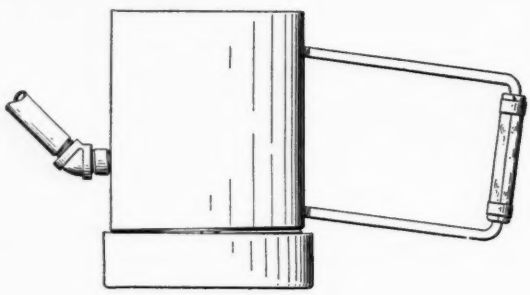
The ends of short pieces of rope were thrust up inside the bedplate, through the channels cut in the foundation and the pieces laid across the rope running around the foundation. These cross pieces tied the concrete inside the bedplate with that on the outside.

The surface of the concrete was brought up to about 6 in. above the top of the old foundation and worked well into the inside of the bedplate by tamping in the channels cut in the foundation. By Monday morning the concrete was set sufficiently hard to allow starting the engine. That was 2½ years ago, and the engine does not now show the slightest signs of movement on its foundation.

Atlanta, Ga. A. M. CARTWRIGHT

Babbitt Melting and Pouring Pot Made of Pipe and Fittings

A COMBINATION babbitt melting and pouring pot is shown, made of pipe and fittings. A piece of 5-in. pipe screwed into a cap comprised the pot. The handle was made of two pieces of ½-in. rod threaded into the pot



and held at their outer ends by a two-piece wood handle clamped in place. A nipple to connect a 45-deg. elbow to the side of the pot and a length of pipe comprised the spout. The pipe should be long enough to extend up to the top of the pot.

This pot has the advantage of keeping back the dross on top of the babbitt when it is being poured. Also bearings can be poured that are not easily reached with the ordinary ladle. If desired a straight handle can be used on the pot. Two holes for the handle may be bored and tapped, one at right angles to the spout and the other parallel to it. The handle may be put into the hole that is most convenient for doing the job, the other being closed with a screw plug.

Toronto, Ont. JOHN JAMES

Soap Used in Water for Spraying Flyash

WATER is often used for spraying flyash from pulverized-fuel furnaces. The efficiency of the process can be increased by adding soap to the water, which causes it to adhere to the dust more readily. The amount of soap required is largely a matter of trial and error; it is usual to commence with 1 lb. soap per 50 gal. of water, and to increase the amount gradually to the point where the dust removal is most efficient. The character of the water affects the amount of soap which must be added, some waters being hard and requiring considerably more soap than others.

Herts, England. W. E. WARNER.

Cheaper Prevention for Caustic Embrittlement

INCREASED steam pressures have again brought into prominence the old question of caustic embrittlement and its prevention. Previous studies indicated that the embrittlement of steel by caustic soda could be controlled by regulating the sulphate-alkalinity ratio in the boiler water. A high ratio was specified for the higher boiler pressures now in common use. The result has been the occurrence of a high degree of concentration in the boiler drums and a large amount of carry-over in the steam which causes trouble in turbine nozzles and blades. The cost of treatment is becoming a significant item in the expense of plant operation.

Like most advances in the art of power plant operation, it is probable that the maintenance of this ratio is a complicated and expensive means of preventing caustic embrittlement, which may be accomplished by simpler and cheaper methods when these are known. The problem is to discover and demonstrate the simpler method if such exists.

The time is opportune for a further study of the whole question of the chemistry of boiler water at high pressures and temperatures. This may be greatly aided by recent studies in the metallurgy of iron and steel and by developments in physical chemistry. This problem of caustic embrittlement deserves the earnest attention of our research committees.

New York, N. Y. C. G. ALEXANDER.

Is a Boiler "Old" at 51 Years — or 20?

IN READING the Annual Report of the Smithsonian Institution for 1930 I noticed the following statement in the secretary's report which I thought interesting:

"One pair of boilers now 51 years old in the central heating plant has been passed by the boiler inspectors for only 60 lb. of steam for the winter, and must be replaced at a very early date."

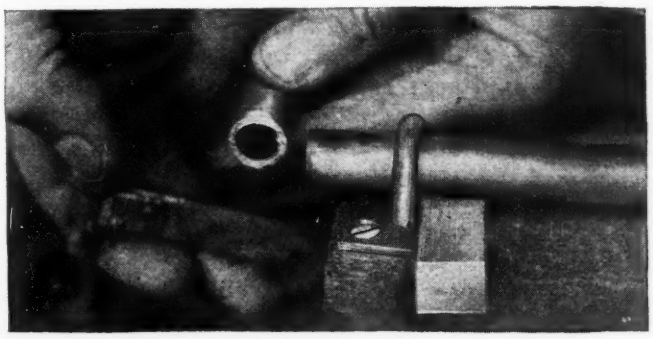
This quotation is found on page 101, beginning in the middle of the last paragraph on the bottom of the page. Is this not a long life for boilers which have probably been in constant use? Would it not be interesting to learn the condition of these boilers and of others of a like age in regard to pitting, feed-water conditions, cleanliness, etc.? Their efficiency, unless the settings were revamped several times during this period of 51 years, would also be of interest.

This report was written on or previous to June 30, 1930. Have they been replaced? It would seem that they would have been replaced long ago because of the advances in boiler engineering. Or were they considered museum objects? Maybe *Power* readers know of much older installations that are still giving service.

Madison, Ind. R. K. SCHELKE.

Emergency Vise Made for Small Pipe or Tubing

WHILE making a hurried emergency repair at a small out-of-the-way pump station, it was necessary to cut off a number of pieces of fairly heavy tubing without a pipe vise. The staple and plate of a hinge hasp for a door were removed and used as shown in the figure. The tubing was slipped through the staple and held firmly with a small wooden wedge. The circular portion of the staple afforded a good holding contact for the tubing with no danger of crushing or bending it. The staples are always firmly riveted and fastened in the plates so that the tubing can be wedged as tight as necessary to hold it for sawing.



R. O. BROWN.

Chicago, Ill.

Welding Assists in Doing a Difficult Piping Job

Fig.1 shows part of the pressure-water header and its branch lines for a bank of hydraulic elevators. The complete header is about 30 ft. long and comprises a duplicate of that shown in the figure extended to the right. Each end of the header connects to the two pressure tanks.

As indicated, the header was constructed with screwed fittings and was installed in a trench below floor level. Apparently the job had been done before the building had been completed, as it would have been practically impossible to replace the header in its original form. Furthermore, the expense of doing the job would be very high.

The header became so badly corroded at several fittings that it had to be replaced. Because all of the elevators in the building were supplied from this header, its replacing had to be done from Saturday afternoon to Monday morning. To do this required careful planning, and it was decided to go to a welded job. This kind of construction not only reduced the cost of doing the work but also resulted in a large reduction in weight.

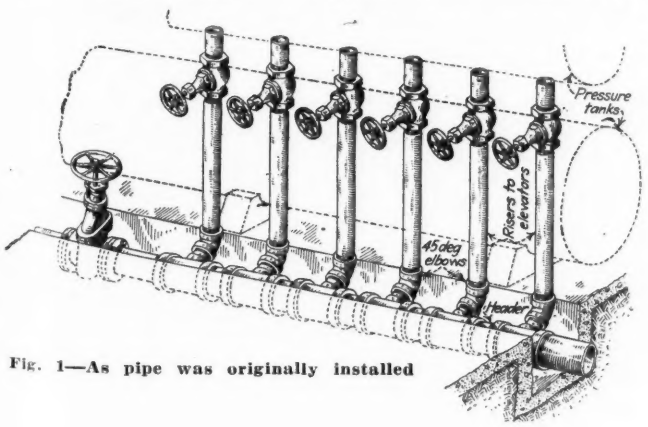


Fig. 1—As pipe was originally installed

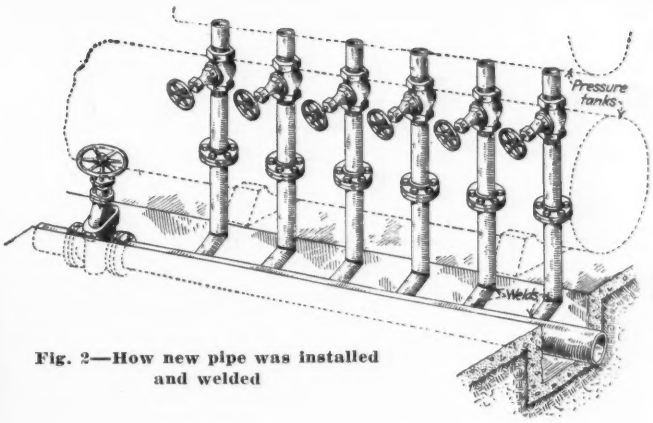


Fig. 2—How new pipe was installed and welded

A new header was fabricated with a flange connection in the center, so that it could be handled in two parts. Instead of the screwed connections and 45-deg. elbows to the risers, the connections were all made by welding as shown in Fig. 2, with a flange between the riser valve and the header.

All the pipe was fabricated in advance and moved into position for quick installation. When everything was in readiness to do the job, work was started installing the header on a Saturday afternoon. The old fitting was easily removed by cutting into sections with a cutting torch and the section of risers below the valves was replaced with the new sections with their flanges. The new header was then put into position and bolted up. The whole job was installed from 2 o'clock Saturday afternoon to 4 o'clock Monday morning.

Cleveland, O. M. E. WAGNER.

Compressed Air Used to Clean CO_2 Recorder Filters

CONNECTIONS for CO_2 recorders, being in the path of the flue gases, are affected by any impurities and dirt in them. In order to prevent dirt and other material being carried into the instrument a filter is usually placed between it and the gas inlet. While this is effective, the filter in time gets clogged, increasing the resistance to the passage of the gases, starving the instrument of gas and causing erratic readings.

The best way to clean the filters is by compressed air. A valve should be placed so that the instrument can be disconnected from the filter and a connection made for the compressed air to pass through the filter in the reverse direction to the gas flow. At first the air pressure should not exceed 10 lb. per sq.in., but should be increased to between 15 and 20 lb. as the cleaning of the filter progresses.

The filter should offer but little resistance to the air flow. If air gages are connected in the pipe on either side of the filter, these will, if the filter is clean, register approximately equal. If the filter is dirty the two readings will differ considerably. Pipe connections must be kept clean. This is very important in the pipe between the filter and the intake from the flue.

Herts, England. W. E. WARNER.

CURRENT COMMENT

Simple Formulas for Tank Capacity Are Easy to Apply

I WISH to comment on the article under the heading "Figuring the Capacities of Tanks and Boilers," which appeared in *Power* for September. The procedure as outlined by Mr. Chadbourne is rather lengthy, and I would like to submit the following formulas, any one of which is much easier to apply and to remember, especially Nos. 2 and 3:

Formula No. 1. $D^2 \times 0.4896 =$ U. S. gallons per 1 inch of height, D given in feet.

Formula No. 2. $D^2 \times 5\frac{7}{8} =$ U. S. gallons per 1 foot of height, D given in feet.

Formula No. 3. $D^2 \times 0.0034 =$ U. S. gallons per 1 inch of height, D given in inches.

Formula No. 4. $D^2 \times 0.0408 =$ U. S. gallons per 1 foot of height, D given in inches.

The measurement *"D"* represents the diameter of a round tank resting on its circular base.

As to memorizing the factors, I would suggest remembering the factors $5\frac{7}{8}$ or 0.0034. The latter factor can easily be remembered by using the principle of "mnemotechnic." Count the zeros at the right hand side of the decimal point and then continue thus:

.0	0	3	4
one	two	three	four

Just remember, 1, 2, 3, 4 and the rest comes to your mind without difficulty.

Peekskill, N. Y. E. BUNZEL.

Bending Copper Pipes

ON PAGE 151 of the September *Power,* W. E. Warner gives some advice in reference to bending copper pipes. Personally, I am not in favor of using pitch, rosin or other material which attaches itself to the interior surface of the pipe. Such material has a tendency to hold or resist contraction of the pipe and may cause ridges to form on the inner side of the bend. Paraffin wax has been used with success and no ridges formed by completely filling the pipe and plugging both ends against the surface of the wax.

When melted lead or tin is used as a filler, cases have occurred where the metal attached itself to the inner surface of a clean pipe, resulting in a resisting effect to a free bending movement.

To prevent such attachment, take a tablespoonful of lamp black and mix it well in a few ounces of a very thin mixture of glue and water, boil the mixture for a few minutes and then fill the pipe with it. At once empty the pipe and dry the interior thoroughly by heating the pipe enough to do so. No soft metal like lead or tin will attach itself to the interior of a pipe so prepared.

Lamp black, glue and water well boiled is what plumbers call "smudge" and is used by them for painting parts of a lead pipe or sheet surface, or other metal surface, to which they do not want any solder to stick or attach itself. J. THORN.

Causes of Motor Operating at Reduced Speed

IN HIS problem in the October number, M.L.K. does not mention whether the 150-hp. motor driving the centrifugal pump ever operated satisfactorily. It is stated that the motor is underloaded at the reduced speed, which in general eliminates all pump troubles and also any possible rubbing between rotor and stator as sources of the trouble.

Assuming that the motor and connections were correct as installed and something has gone wrong since, the trouble may be one of the following:

1. Poor contact between brushes and slip-rings, due to eccentric slip-rings or sticking brushes. This is usually indicated by sparking at the brushes.

2. Voltage at generator may be low due to incorrect reading of the voltmeter. The voltage at the switchboard should be carefully checked.

3. Voltage at motor may be low because of poor connections in the controller, switches or power leads. To test the motor's voltage, a voltmeter should be attached to the motor leads at the motor, testing all phases while the motor is running under load.

4. If the motor is three phase, delta connected, there may be an open circuit in the stator winding. A break in one of the three leads of this type of motor will prevent it from starting but will not stop the motor after it has reached a certain speed. A break in one of the two wires connected to each lead of this type of motor will not prevent its starting but will prevent its reaching normal rated speed under full load. The simplest test for an open circuit in the stator winding is the ammeter test. If all phases do not show about the same current on the ammeter, there is probably an open circuit in the motor.

5. In the case of a wound-rotor motor, the effect of an open circuit in the rotor winding is the same as an open circuit in the stator winding. The ammeter may be used in the same way as in No. 4.

6. A badly burned finger or plate on the last point of the controller would prevent the motor from reaching normal speed under load. The last point on the controller should short-circuit the secondary leads with the least amount of resistance possible. If the last point on the controller leaves some resistance in the circuit, then the controller is not properly connected for this service.

If the troubles suggested in paragraphs 1, 2, 3 and 6 are found to be non-existent, and an ammeter is not available to make the tests suggested in paragraphs 4 and 5, proceed as follows:

7. Test both primary and secondary carefully for grounds.

8. If no grounds exist, then remove both end bells from the motor and examine all windings carefully. A burned spot in the insulation or paint will indicate the location of the trouble. Be sure to remove the rotor from the stator and examine the stator slots.

9. If all windings are in good order, then disconnect the motor stator-winding terminals from the external leads and tape two of them to prevent shorts and grounds. Pull the untaped motor terminal through the motor frame toward the end where the coil connections are made, follow this lead back toward the windings until the splice is found where the two delta leads are joined to make the motor lead. Separate the two delta leads. Then with a 110-volt light circuit and lamp test through the windings. The lamp should glow when the test circuit is touched to the two delta leads. Failure of the lamp to glow would indicate an open circuit.

The secondary or rotor windings are not so readily tested. An open circuit in these windings will usually be indicated by melted solder, burned spots or other indications.

Wilmington, Del. C. E. MOULSON.

Testing Non-Condensing Turbines for Efficiency

IN THE August, 1932, number of *Power*, page 74, Guy B. Randall discusses a method for testing non-condensing turbines for efficiency and suggests that the method "would appear to constitute a worthwhile revision and enlargement to the" A.S.M.E. Test Code for Steam Turbines.

As chairman of the A.S.M.E. Power Test Codes Individual Committee, which prepared the present Test Code for Steam Turbines, I feel impelled to point out that the method discussed by Mr. Randall was thoroughly covered in a report by Messrs. Stansbury and Weil, published eleven years ago (*Power*, Dec. 6, 1921). These gentlemen, then graduate students at the Johns Hopkins University, investigated the method rather fully, and pointed out the precautions necessary to secure reasonably dependable results.

The A.S.M.E. committee on turbine testing discussed this method carefully, and reached the conclusion that it could not properly find a place in the Test Code, because it is not a method of testing in the strict sense of the word. We recognized it as a valuable and useful method of inferring the performance of the machine, sufficiently accurate for purposes of information.

On the other hand, it must not be forgotten that the A.S.M.E. Test Codes are planned for use in acceptance testing and must, therefore, be so drawn that their results can be defended in litigation that may arise from a disagreement. The methods presented in such a code must be only those that are recognized as yielding the most dependable results attainable in the present state of the art. The Code cannot lead practice; it must follow. This point of view explains many omissions from the present Code, and its next revision will doubtless embody several items in recognition of recent advances in the art.

The Stansbury-Weil method, advocated by Mr. Randall, is obviously limited to turbines operating under such circumstances that the state of the exhaust steam can be completely determined. If the exhaust is superheated, this can be done fairly readily, as Mr. Randall points out. If it is wet, this is not the case. The determination of the quality of low-pressure steam is as yet a matter of research, and the accurate determination of the quality of high-pressure steam presents many difficulties.

An error of one per cent in the measured quality of the exhaust steam will produce an error of about ten B.t.u. per pound in the corresponding value of the work developed per pound of steam, and this may result in error of from five to ten per cent in the computed engine efficiency of the turbine. An experienced turbine engineer could perhaps guess the efficiency as closely.

The A.S.M.E. committee on turbine testing is not yet willing to admit any test procedure whose results depend upon the determination of the quality of wet steam, whatever its pressure, as it is believed the quality of steam cannot be measured with anything approaching test code accuracy.

Cambridge, Mass. C. HAROLD BERRY
Professor of Mechanical Engineering, Harvard University.

Short-Circuit on Generator Prevents Turbine Operating at Full Speed

THE short article, "Poor Connections Cause Generator to Shirk Its Load" by T. O. Dunn in the October number of *Power* is another illustration of how trouble shooters fail because they do not dig deeply enough for the fault. Apparently everyone who had to do with locating the fault mentioned by Mr. Dunn worked on the conclusion that the cause was in the machine, and never considered that the machine was connected to a lot of wire that might hold the answer to the problem. As Mr. Dunn has pointed out, one of the first things to have done would have been to check the connections and make sure that they were in good condition. If this had been done there would have been no mystery about the trouble.

Some years ago I had a similar experience with a small turbine generator that failed to come up to full speed. The unit was a new one and was being started for the first time. The erecting engineer failed to find the cause of the trouble, believing that the only source of the fault must be in the turbine. An engineer was sent from the factory by the turbine manufacturer, who also, after several attempts to find the trouble in the turbine, was ready to admit defeat.

At this stage, the engineer who was to operate the plant suggested disconnecting the generator leads at the machine and trying the machine without any outside connections. Very much to the surprise of the manufacturer's engineer the unit came up to full speed and operated perfectly. It was found that a mistake had been made in the wiring that short-circuited the generator.

Here again one of the first things that should have been done was neglected, when the turbine failed to come up to speed, that is, to have disconnected the turbine and tried it without any connected load. This would immediately have shown that the turbine was not at fault.

Philadelphia, Pa. R. M. BARBER.

READERS' PROBLEMS

WEIGHT OF COMPRESSED AIR—*What is the weight of 35 cu.ft. of dry air at a temperature of 150 deg. F. and a pressure of 75 lb. per sq.in. gage?* C.R.M.

The weight of dry air varies inversely at its absolute temperature and directly as its absolute pressure and may be determined by the formula:

$$W = \frac{TP_1V_1}{T_1PV}$$

Where:

W = weight, in lb., of the total volume of air at stated conditions.

T = 492 = absolute temperature corresponding to 32 degrees Fahrenheit.

T_1 = absolute temperature of the air at the conditions in the given problem.

P = 14.7 = atmospheric pressure in lb. per sq.in.

P_1 = absolute pressure, in lb. per sq.in. of the air at stated conditions.

V = 12.4 = volume in cu.ft. of 1 lb. of air at atmospheric pressure and an absolute temperature of 492 deg. F.

V_1 = Air volume in cu.ft. at pressure P_1.

In this problem, T_1, the absolute temperature of the air, equals 460 + 150 = 610 deg. F. abs., and the absolute pressure of the air is 75 + 14.7 = 89.7 lb. per sq.in. Then the weight of the air is:

$$W = \frac{492 \times 89.7 \times 35}{610 \times 14.7 \times 12.4} = 13.9 \text{ lb.}$$

It Pays to Insulate Flanges

Readers answering September question agree that flange insulation pays, but differ on the when, where and how

The Question

THERE seems to be some difference of opinion among engineers as to the advisability of insulating flange joints in steam lines. On the one hand some point out that a pair of 6-in. flanges, left bare, will waste about one ton of coal per year and that bare flanges add to the discomfort of boiler and engine rooms in the summer time. On the other is the fact that flange insulation costs much more and saves less per running foot than the regular pipe insulation. Moreover, built-on flange insulation must be destroyed whenever it is necessary to get at the joint because of leakage. I would like to get the opinion of POWER readers as to the desirability of insulating steam flanges in general, and in particular locations, also the relative advantages of fixed and removable covers. D.F.R.

May Not Always Pay

THE advisability of insulating steam pipe flanges today depends upon the conditions in the particular plant. If a new plant is being built, all flanges on the permanent piping should be covered both for looks and financial returns.

The present state of business and the financial affairs of most plants are such that money for pipe flange covering is not available nor is the covering of flanges on old installations advisable. This may sound ambiguous in view of the preceding paragraph but so many plants have restricted expenditures for plant upkeep that any money spent would show a much greater return on the investment if used elsewhere than in flange insulation.

There are a number of things that affect the decision on this work, such as moisture content of the steam, protection of persons working near the flanges, number of hours per year pressure is carried on line, whether indoors or out, and the cost of the finished job.

I have in my scrap book an article that appeared in *Power* on "How to Apply Heat Insulation," by P. W. Swain, Associate Editor. This article gives an excellent detailed description of pipe and flange covering. It also clearly shows the extra work and cost in making removable flange covers. I believe that their uses should be in special cases rather than general. Johns-Manville's book, "Service to Industry," also contains much valuable information on pipe insulation.

As to particular locations, the engineer should use his own judgment, and if he is conscientious he will not go far wrong. Out of doors, pipe, flanges, and valves should be well insulated and well covered for protection against the weather. Inside, common sense should be the rule and guide.

BURTON W. WHEELER.

Rockland, Mass.

Prefers Removable Covers

I BELIEVE that all steam pipes and flanges should be well insulated. There is a "box" insulation made in sections for flanges and valves of all kinds. It is put on in sections and held on by a band. When it becomes necessary to repack the flange, the sectional covering can be removed easily without damage to the insulation. The removable insulation is better than the fixed for flanges. JOHN L. WHITE.

Lima, Ohio.

And Why Not on Land?

FIRST, I venture to disagree with the statement that flange insulation saves less per running foot than other pipe covering. To prove this it is not necessary to get technical. Room heaters are made with fins to increase heat radiation, and what is a flange but a glorified fin?

On shipboard where wet steam is met with oftener than ashore, due to pitching, rolling, etc., flange joints have to be made oftener than in land plants. Yet they are covered.

We make an asbestos cover over a wire net frame in two sections with an over-all strip of thin metal to hold the cover in place. This is easily removable, can be used indefinitely, is economical in that it prevents heat loss and saves coal and certainly raises the general appearance of the engine and boiler rooms. M.G.B.

Passaic, N. J.

Coal Cost is Just One Item

THERE should be no question as to the advisability of insulating the flanges of steam piping, because the area exposed to radiation is comparatively large, especially with extra heavy piping. The argument that the heat has to travel through a greater area in the flanges than it does through the pipe itself is a poor one, as the conductivity of the metals usually used is high. Consequently the loss, while less than for an equal area of pipe, is not much less.

It is true that flange insulation is easily damaged by removal, but it is also easily repaired, as many engineers do not seem to know. Most insulations are made of a non-conductive material such as asbestos, magnesia or barium carbonate which owe their insulating qualities to the large amount of air enclosed or adsorbed by each particle, but in every case silicate of soda is used in the least possible quantity. By beating the old insulation to a pulp, it can in most cases be remolded without difficulty after moistening with water and allowing to stand for a few hours. More

silicate of soda may be added, but in excess, it displaces the air which is the real insulating medium.

How often does one have to take down a job after it is installed? Of the hundreds of flanges that you have had in your charge, Brother Engineer, how many have you had to tear down? This will answer one argument. As to the question of fixed and removable covers, unless the latter is as cheap as the former, or one expects to change his piping several times before settling down to a steady load, I would use the fixed covering. In the latter case, I would defer placing the covering until I was reasonably sure that I had the piping about as I wanted it.

As to the saving in coal by use of insulation, I have never been convinced that in normal installations the saving in coal will more than pay for the interest and depreciation on the covering. I am an advocate of covering because it keeps the steam dryer, saves loss at the traps, facilitates lubrication and prevents broken heads and valves. These advantages cannot be measured in dollars and cents, but any engineer can appreciate them. L. R. BAKER.

St. Louis, Mo.

Fewer Leaks When Covered

THE heat losses from uncovered flanges will amount to a considerable sum in a year. Except in small confined spaces, the amount of discomfort caused is not worth considering.

I have found it pays to cover flange joints because it eliminates cold air striking the flanges and causing unequal expansion of pipe and flange. Covering practically does away with leaking joints because flanges and pipe and bolts have practically the same temperature and expansion.

I have worked in power plants where flanges were left uncovered and it meant renewing leaking joints every few weeks. After insulating the flanges, only on rare occasions was it necessary to remove the covering and repair the joints. I have in mind flanges that are covered and have not shown a leak in ten years.

There is no advantage in using removable covers molded to shape. They are expensive and do not last any longer than fixed or built-on covering, as they are generally broken on removal from flanges to make a repair.

The whole question simply is: If you wish tight joints, then cover the flanges. If you wish leaks, then let the air strike the hot flanges and you have plenty of work. GEO. L. BRUNING.

Collingdale, Pa.

Flange Covers Pay

THE radiation loss incurred with a pair of 6-in. flanges left bare is stated in the problem to be about 1 ton of coal per year. Naturally, with larger flanges, the loss would be proportionately greater. Such a loss, assuming $4 per ton coal, would surely be greater than the labor and material required to cover this single joint, even though the insulation had to be replaced twice per year. It is evident that very few joints require reinsulation so often; in fact, many joints are installed having five or even ten years' service without the covering being disturbed.

Any labor and material saved by having flanges bare on new work would be partially offset by the cost of "finishing" the ends of the piping insulation on each side of the flanged joint. Even when an old bare joint is broken, some damage is usually done to the adjacent insulation when removing the bolts. Therefore, the labor and material saved by bare joints is not as great as might be expected.

A removable covering should not be considered for small work, due to high cost. Where fairly large joints are frequently broken for inspection of equipment, the removable cover is quickly replaced and requires only a slight cost to seal the edges with asbestos "mud." This type of cover is particularly applicable to casing joints of turbines, cylinder heads, manhole plates, handhole plates on exposed headers of water-cooled furnace walls, and many other uses. F. E. BERRETT.

Baltimore, Md.

A Question for Our Readers

WE have a 1,000-kva., 2,300-volt, 60-cycle, 3,600-r.p.m. alternator, driven by a steam turbine, that has been giving trouble by developing flat spots on one of the exciting-current slip rings. The ring has been trued and polished and the leads interchanged, but it continues to develop burned spots all around its surface. It does not seem that the trouble is in the brushes, as they are those recommended by the machine manufacturer; their spring tension has been checked, and they move freely in the holders. Perhaps Power *readers can suggest a remedy for the trouble.* M.R.C.

Suitable answers from readers will be paid for if space is available for their publication.

New Covers from Old Material

WE SOLVED the problem of what to do about insulating flange fittings in quite an economical manner. For years the flanges on our steam lines had been bare, not so much because of the cost of insulation but more because we were so busy on production. Then, when we suddenly found we had plenty of time and the need of putting every possible economy into effect we discovered the office had shut down on purchases of all kinds.

The engineer did not worry about that, he was not the worrying sort, instead he hunted up a lot of old bashed-up covering, stripped off the canvas and dumped the magnesia insulation into the mud mill that he had cleaned out. Then he added water and made a stiff dough. This he started to plaster over the flanges, and the stuff fell off about as fast as he tried to stick it on. This did not worry him either, for he hunted up some light coarse-mesh wire, such as we used over the cellar windows to keep cats and mice out, and he wired a semi-circular strip to the underside of the fitting and about 1¼ in. away from it.

This effectively prevented the covering from peeling off, and he was able to plaster a nice layer of dough over the entire fitting. It looked good and was a kind of flattened-out ball in shape. The engineer then tore some cheese cloth into narrow strips and bound the insulation just like the nurse wraps a bandage around a bum knee. This made a neat job, but it did not look any too elegant until he gave it a coat of filler and painted it gray; then it was satisfactory in every way.

No effort is made to make these covers removable for we practically never have to touch a flange unless we are going to tear the line down or change things, and it is just about as easy to break it all off and plaster on a new one anyhow, now that we know the trick. GEO. P. PEARCE.

Moline, Ill.

For High Pressure, Chiefly

SUFFICIENT specific data was not given in the question to calculate numerical results. However, in general it pays to insulate all flanges in the high-pressure section of the plant cycle, as heat saved in this section is used to do useful work. In the low-pressure section of the plant cycle the heat in the steam does not have as much value due to its lower pressure. Further, owing to a smaller temperature difference losses per square foot of area are less than on high-pressure lines.

Hence it is quite common to leave flanges on exhaust lines uninsulated unless special considerations, such as effect on adjacent cooled water lines or electrical conduits, dictate otherwise. However, it is well to determine the cost of operation of uninsulated flanges as against insulated flanges because the heat loss in the exhaust section of the plant is appreciable.

Other reasons for insulating flanges are reduction of temperature stresses in the flanges, more comfortable room temperatures, better appearance of the pipe line and greater ease of cleaning the line.

Removable joint covers facilitate maintenance and are desirable on lines 6 in. and above. Below that size, plastic flange covering is adequate.

JOHN D. MCKECHNIE.

Hillburn, N. Y.

THE ENGINEER'S BOOKSHELF

Thermodynamics

THERMODYNAMICS. *By J. E. Emswiler, professor of mechanical engineering, University of Michigan. Third Edition. Published by the McGraw-Hill Book Co., 330 West 42nd St., New York City. 347 pages, 6x9 in. 162 diagrams, 12 tables. Clothboard covers. Price $3.*

Presentation and arrangement of the earlier editions has been improved through rewriting, particularly in the chapter explaining how steam does work in a turbine engine, and in those dealing with the ideal steam cycle, available energy of steam and nature of losses in a utilizer. Much of the chapter on flow of fluids has also been rewritten, and new material has been introduced where necessary to bring the work up to date. Important additions include two tables on properties of ammonia, an extensive treatment of the principle of the absorption system of refrigeration, and in this connection an introduction to the idea of the use of solutions in power cycles, a summary of the numerous forms of the gas equations, an extensive article on the supersaturation of steam, and similar information.

References throughout have been changed to refer to the new Keenan steam tables. Problems for test and explanation are included. Other similar changes in the interest of up-to-dateness and ease of reading have been incorporated, in the effort to maintain the author's idea in writing the work originally, namely to present thermodynamics as a connected subject rather than a maze of disconnected, highly theoretical information.

Refrigeration

REFRIGERATION. *By James A. Moyer and Raymond U. Fittz, second edition. Published by the McGraw-Hill Book Co., 330 West 42d St., New York City. Cloth, 9x6 in., illustrated, 538 pages, price $5.00.*

The authors of this text on refrigeration have found that progress in refrigeration and air conditioning in the past four years required a complete revision of the book. Three new chapters have been added, and practically all of the other chapters have been expanded.

The new chapters deal with small commercial refrigerators, quick freezing and production of solid carbon dioxide. Those chapters to which the most new material has been added are household mechanical refrigeration, ice making and air conditioning. These include important new features such as improved designs of household and small commercial refrigerating units, silica-gel refrigerating systems, new small capacity absorption plants and methods of controlling refrigerants. Tables of properties of refrigerants have been revised and Mollier charts added for carbon dioxide and sulphur dioxide as well as data on the properties of dichlorodifluoromethane.

Electrical Definitions

REPORT OF PROPOSED AMERICAN STANDARD DEFINITIONS OF ELECTRICAL TERMS. *Printed by American Institute of Electrical Engineers, 33 W. 39th St., New York City. 1932. Paper. Size 7¾ x 10¾ in.; 205 pages. Price $1.00.*

The American Standards Association approved the initiation of this work in 1928 on the recommendation of the A.I.E.E. Standards Committee. Over 300 engineers representing the various branches of electrical engineering have contributed to preparing these definitions.

The aim in compiling this glossary has been to express for each term the meaning which is generally associated with it in electrical engineering work in this country. These definitions include those applying to rotating machinery, transformers and rectifiers, switching equipment, control equipment, instruments, generation and distribution, transportation, electromechanical applications, welding and cutting, illumination, electrochemistry and electrometallurgy, wire communication, radio communication, radiology, electrobiology.

By-Product Coke

GLUUD'S INTERNATIONAL HANDBOOK OF THE BY-PRODUCT COKE INDUSTRY. *By D. L. Jacobson, chemical engineer, The Koppers Co. American Edition; 1932. Published by the Chemical Catalog Co., Inc., 419 Fourth Ave., New York, N. Y. 879 pages, 6x9 in. 414 illustrations. Clothboard covers. Price $15.*

Several years ago, a handbook of the byproduct coke industry in two volumes appeared in Germany. It has since been realized that the coke industry varies but little the world over, so that an international handbook might be prepared. As a result of an agreement between the German author, Dr. Gluud, an English company, and the Koppers Co. here, the entire work was revised, brought up to date, and has now been published in German, English and French. D. L. Jacobson was the principal American author of the group. Dr. Gluud, in charge of the Gesellschaft für Kohlentechnik at Dortmund, is the leading authority of the coke industry.

The book is a compendium of all available information on byproduct coke, and as such should prove of tremendous importance to its industry. It is easy to read, plentifully illustrated, and provides (for the first time in English) a vast amount of technical information. For power plant engineers specifically, Chapter 5 of the technical section, "Steam Generation at Coke Oven Plants" (10 pages) is of interest.

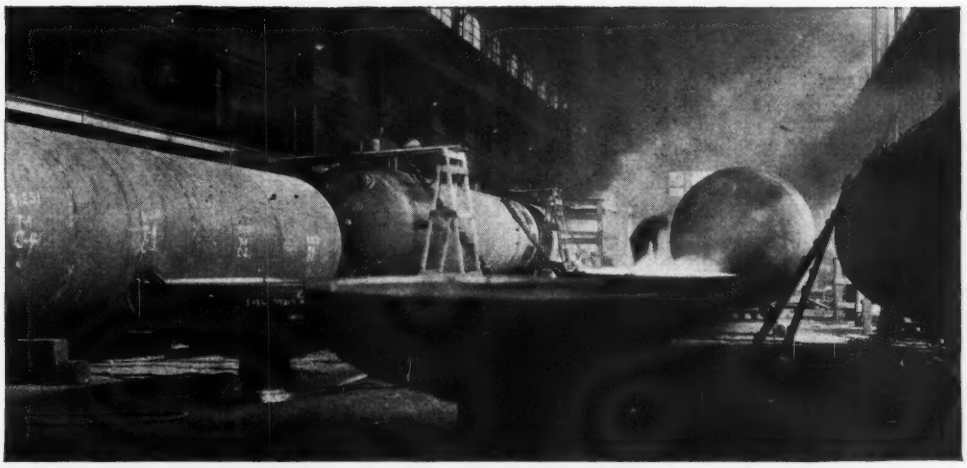
BRIEF REVIEWS

SOLUTION OF SPECIAL PROBLEMS IN PIPE FLOW BY GRAPHICAL ANALYSIS. By Grant K. Palsgrove, M.E. Number 37 of the Engineering & Science Series of Rensselaer Polytechnic Institute. 29 pages, 6x9 in.—Fundamental cases of various pipe flow problems are solved and discussed, thus providing a method of attack which with slight variations may be used for any compound or multibranch system of feeders and their varying conditions.

REMOVAL OF SOOT FROM FURNACES AND FLUES BY THE USE OF SALTS OR COMPOUNDS. Bulletin 360 of the Bureau of Mines, U. S. Department of Commerce. 76 pages, 6x9 in. Paper covers. 18 illustrations. Available from the Superintendent of Documents, Washington, D. C.—Report of an investigation to determine whether there is truth in popular belief that salt, zinc wastes, and various trademarked compounds remove soot. Shows that only with high temperature flue gases are such compounds practical, and then should be supplemented by mechanical cleaning.

REFRACTORIES. Report of A.S.T.M. Committee C-8. Available from American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa.—Bringing the subject of refractories work of the society up to date.

PETROLEUM PRODUCTS AND LUBRICANTS. Brings together conveniently the various A.S.T.M. standard test methods for petroleum and its products and 1932 report of Committee D-2. Authorized reprint from copyrighted publications of American Society of Testing Materials, 1315 Spruce St., Philadelphia, Pa. Price $1.25—48 test methods given, 33 being standards and remainder tentative standards. Revisions involve test methods for flash and fire points with open cup, test for cloud and pour points and test for viscosity. Added are standard test method for distillation of natural gasoline, color tests for lubricating oils and for petrolatum with A.S.T.M. Union calorimeter, tests for gravity of petroleum products with hydrometer, and test for vapor pressure of natural gasoline.



Welding has become a major tool of pressure-vessel manufacture

POWER FIELD AIDED

By Welding Advances

Welded Pressure Vessels, Fundamental Research, Qualification of Welders Discussed at Twelfth Fall Meeting of American Welding Society

IN SPITE of adverse business conditions, the twelfth fall meeting of the American Welding Society, held in the Hotel Statler, Buffalo, N. Y., October 3-7, was notable for the variety and importance of the papers presented. More than 250 leading engineers attended the sessions, some of which were held at the Statler Hotel and others at the 174th Regiment Armory. The National Metal Exposition was held at the Armory in connection with the meeting of the Welding Society and that of other technical societies holding simultaneous meetings in Buffalo. A large part of the exhibits were devoted to welding equipment, and to welding jobs, including tanks and pressure vessels.

A feature of the annual dinner was the presentation of the Miller Medal to Frank P. McKibben, President of the American Welding Society. Mr. McKibben was awarded this medal for outstanding achievement in the field of structural welding.

Papers presented at technical sessions dealt with pressure vessels, qualification tests for welders, fundamental research, the welding of alloys, the uses of the oxyacetylene cutting torch, and many other welding subjects.

Discussing the application of welding to pressure vessels, P. R. Hawthorne, of the Struthers-Wells Co., outlined the welding technique used by his company, with particular emphasis on stress-relief and X-ray equipment used in producing and testing A.S.M.E. Class 1 welds.

The process used is the Struthers-Wells Co. "tempered arc" coated electrode, welding being done in a gaseous sheath to prevent contamination of metal while in vapor or highly liquid state. Mr. Hawthorne stated that, through a combination of chemical reaction and metallurgical changes, this process produces welds with properties far exceeding Code requirements. The Code requires that Class 1 vessels, after welding, be brought up slowly to 1,200 deg. F., and held at this temperature for 1¼ hr. before being allowed to cool slowly in the furnace to room temperature. To provide for such normalizing of vessels of large size, Struthers-Wells Co. has in operation a furnace whose inside dimensions are 13 ft. wide by 15 ft. high by 82 ft. long.

J. C. Holmberg, of the same company, in a paper on the metallurgy of welds, stressed the great progress made in producing ductile welds. "Welding has progressed from the point where weld metal was virtually all tensile strength and no ductility, to the point where properly made welds contain metal much more ductile than the plate, and still maintain sufficient strength."

Lawrence I. Leveen, of the General Electric Co., announced further progress in automatic welding with heavily coated electrodes. The use of these electrodes is made possible by the use of a high-speed cutter which removes a portion of the flux material near the working end, allowing for the introduction of current.

An entire session was devoted to fundamental research in welding. John T. Norton, of the Massachusetts Institute of Technology, reported further progress in the use of X-ray diffraction patterns to determine the internal stresses in welds. The results of an elaborate corrosion-fatigue study of welded low-carbon steel were presented by Wilbur E. Harvey and F. Jerome Whitney, Jr. From these they drew the important conclusion that arc welding does not have a bad effect upon corrosion fatigue limits, except where bare wire is used.

At the same session, G. E. Doan, of Lehigh University, and J. M. Weed, of the General Electric Co., presented the results of researches on metal deposits in electric arc welding, while S. C. Hollister and A. S. Gelman, both of Purdue University, dealt with the distribution of stresses in welded double butt-strap joints.

Closely related to this fundamental research session was an evening conference and meeting of the Fundamental Research Committee. Participating in this were fifteen university professors.

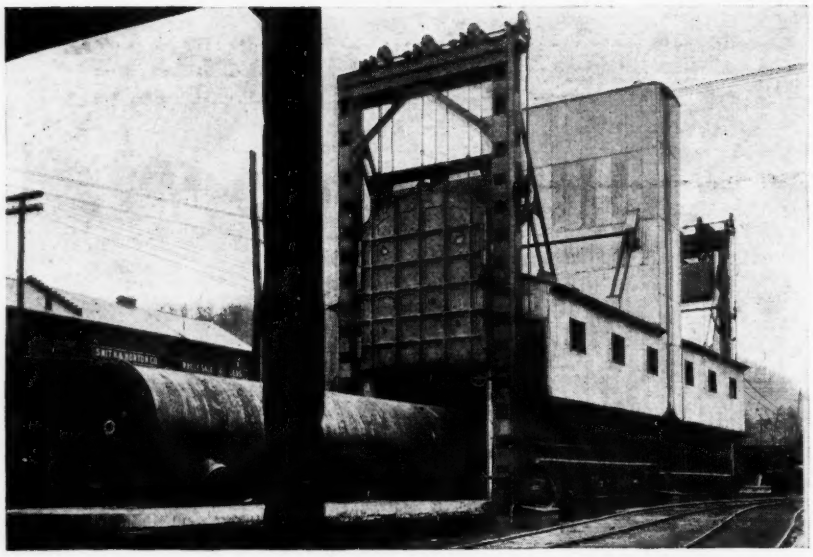
At the present time some 37 different welding research projects are under way in the universities. The American Bureau of Welding, the research department of the American Welding Society, is co-operating closely with these institutions by supplying test specimens as needed and by helping formulate research problems. The bureau also contributed toward the expenses of the pro-

fessors from various colleges who attended the meeting.

In another session, qualification tests for welders were discussed by E. Lunn, Chairman former Committee on Qualification of Welders, by H. E. Rockefeller, of the Linde Air Products Co., A. Vogel, of the General Electric Co., and by V. P. Marrann, Walsh-Holyoke Steam Boiler Works. The discussion centered chiefly around the high cost of applying the A.S.M.E. Code qualification tests. In the interest of economy, it seemed desirable to establish less expensive pre-qualification tests. These would reduce the cost of the final test by reducing the number of men who take them. They would likewise save the cost of educating further the welders who, under the present system, take the final test and fail.

In his paper, Mr. Lunn said: "the most trying time in a man's welding career is during the period when he is endeavoring to train his muscles to act in ways to which they are not accustomed, and to force them to perform at once as they ordinarily do after weeks and months of patient effort. The apparent simplicity of the various welding processes is likely to lead to erroneous conclusions on the part of the uninitiated operator.

"Decision as to whether a man is fit to work on a certain job is not answered by how long he is going to school, or for whom he has worked, but by his ability to make welds that the particular job requires." Mr. Lunn concluded that qualifying tests are essential for this reason.



Giant stress-relieving furnace in Struthers-Wells plant. Photo illustrating paper of P. R. Hawthorne

At the same session, J. C. Hodge, of the Babcock & Wilcox Co., presented a technical study of the chemistry of low-carbon metal arc weld metal. He showed a close relation between the degree of protection of the molten metal against atmospheric gases; and the ultimate composition of the weld metal.

Among the other papers presented at the Welding Society meeting was a discussion of welded rolled steel designs for the iron and steel industry by Christian A. Wills, of the Wm. B. Pollock Co. It showed that the replacement of riveted and cast construction by welding is advancing rapidly in the steel industry, as elsewhere, and that the time has arrived when customers frequently request welded design.

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LOW-HEAD HYDRO PROJECTS

Featured at A.I.E.E. Meeting

WITH the Lord Baltimore Hotel, Baltimore, Md., as headquarters, the middle eastern district of the American Institute of Electrical Engineers held its fall meeting Oct. 10 to 13. At the power sessions, water power was treated from the economic aspect, with particular reference to the design and construction of low-head plants. Special attention was given to the Safe Harbor project of Safe Harbor Power Corporation, which has installed in it the highest-powered Kaplan turbine in the world. Four of the six papers presented at the power sessions dealt with different phases of this project.

F. A. Allner, general superintendent, Pennsylvania Water and Power Company, in a paper, "Economic Aspects of Water Power," surveyed the economic relation of hydro and steam power and discussed the possibilities of using the same unit for power generation and pumping water in pumped-storage hydro plants.

Fundamentally, said Mr. Allner, the benefit derived from the two sources of supply, hydro and steam, comes from the combination of low operating cost for hydro with low unit investment cost for steam. While the total investment to carry the system peak may be larger in a combined system than with steam alone, the excess investment is more than compensated for by the low cost of energy derived from hydro. The two sources of power should be regarded as supplementing rather than competing with each other. Some of the benefits of hydro on the system were summarized as follows:

The quick starting characteristics of hydro units provide a high degree of standby readiness for emergencies. Hydro units, especially the low-head type, are well adapted to maintain system frequency. Hydro pondage or storage can be drawn upon to relieve the steam plants and save banking of extra boilers and generation by less efficient units and to facilitate the advance scheduling of equipment for generation, as well as for withdrawal from service for inspection and maintenance. Hydro generators are also adapted to no-load operation as synchronous condensers for voltage regulation or power-factor correction.

A considerable part of the paper was devoted to a discussion of pumped-storage installations in which the units are to be used for the dual service of generating power and pumping water.

An abstract of this part of the paper appears on page 266 of this number.

In a paper, "Safe Harbor Project," N. B. Higgins, assistant chief engineer, Safe Harbor Water-Power Corporation, gave a comprehensive description of the Safe Harbor development. The power house and dam have a combined length of 5,000 ft. In the initial project there will be installed 255,000 hp. and in the completed development 510,000 hp. One of the features of the project is the 42,500-hp. Kaplan turbines for 55-ft. head. These are the most powerful units of that type ever built and have the largest dimensions of any hydro units installed on this continent. An extensive description of this project was published in *Power* March 15 of this year.

W. S. Lee, discussing this paper, called attention to the problem of supplying both 60-cycle and 25-cycle power from the same plant. At the Beauharnois development on the St. Lawrence River, where they have the same problem, it is planned to install a 60-cycle and a 25-cycle generator on the same waterwheel.

Difficulties Overcome

B. M. Hess said Safe Harbor plant had been in operation for about 10 months, and although some generator and thrust-bearing trouble had been experienced after the plant was started all these difficulties had been overcome. The runners are located 7 ft. below tailwater, and to inspect them compressed air is admitted into the wheel casing. This has worked out successfully. After the water has been depressed below the runner, very little additional air is required to keep it at the desired level.

Carroll F. Merriam commented on the governor system at Safe Harbor, which is a compromise between the unit and and the central systems. The governing oil-pressure systems on each two units are interconnected so that either may serve both. The governor pumps and their piping connections are so arranged on their bed-plates that a pump can be removed simply by taking the nuts off the holding-down bolts.

The Safe Harbor turbines, the design of their settings and cavitation limits as developed at the Holtwood laboratory were described in a paper by L. M. Davis, hydraulic test engineer, and G. W. Spaulding, assistant general superintendent, Safe Harbor Water-Power Corporation. Safe Harbor plant is the first large hydro-electric project in this country to install Kaplan turbines.

The authors express the opinion that while the development of the Kaplan or adjustable-blade turbine has taken place to the greatest extent in Europe, the development of the propeller turbine, particularly the extension of its field to larger powers and higher heads, has been carried out to the greatest extent in America. The availability of propeller turbines for heads over about 30 ft. has been due mainly to American engineers.

Economic relation of hydro-electric to steam plants on the same system; pumped-storage hydro-electric plants; the 510,000-hp. Safe Harbor project and its 42,500-hp. Kaplan turbines under a 55-ft. head; progress made in theory and practice as applied to low-head developments — these were the subjects of a full day's discussion

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The Safe Harbor plant has a relatively low operating head, limited storage, wide fluctuations in river flow and operating head, and its peak-load value, as distinguished from a base-load plant, is of prime consideration. Appreciable savings in the cost of power-house structures were found possible by using propeller-type turbines. Further savings in the cost of the electrical generators were obtainable with propeller turbines due to their higher speeds, which permitted the use of smaller and consequently lower-cost generators and their direct-connected exciters.

The Safe Harbor units, rated at 42,500-hp., are spaced 62 ft. apart, while high-speed francis-type turbines capable of developing the same horsepower under the same head would have to be spaced 70 to 75 ft. apart. For the same unit spacing of 62 ft., a francis turbine would be capable of developing only 30,000 to 35,000 hp., which would obviously require power-house structures of appreciably larger proportions to obtain the same plant capacity. Again, the speed of the Safe Harbor units is 109.1 r.p.m., whereas the speed of the same capacity francis turbine would be only about 60 r.p.m.

The automatically adjustable-blade Kaplan turbine has certain additional advantages over the fixed-blade propeller type. A very flat efficiency curve is obtained, it is possible to operate the unit considerably above its normal power rating for short periods of time and without appreciable loss in efficiency, it has materially greater output when operating under reduced heads and is more stable when operating at part load. Due, however, to the additional mechanism required for blade adjustment, the Kaplan turbines are more expensive, both in first cost and in maintenance.

As part of the work in designing this plant, an extensive test program was conducted at the company's hydraulic test laboratory at Holtwood, Pa. This laboratory was designed for testing model turbines 16 in. in diameter (approximately one-fourteenth the size of the actual Safe Harbor units) with complete wheel setting and water passages including intake, scroll case, wheel casting and draft tube, under a range in test head varying from 4 to 60 ft., and for purposes of cavitation tests the draft head may be varied from approximately 10 ft. pressure to 10 ft. suction.

Tests on a complete model of the Safe Harbor intake, scroll case, wheel setting, runner and draft tube were made to determine within close limits the highest elevation at which the runner could be set without danger of serious cavitation for the maximum turbine power required. Correlated with the study of cavitation limits of the turbine and the proper runner elevation was the problem of draft-tube design. A series of scroll-case tests was made to determine if there would be any advantage in offsetting the center line of the runner shaft, from the center line of the intake, thereby increasing the cross-sectional area of the scroll case and reducing the velocity of the water.

To insure that the units are properly adjusted and operating to give the best efficiency, numerous field tests and inspections were planned. During the first few months of operation the turbines were inspected about every two weeks. Those inspections are now made about every six weeks on each unit. It has been found that on certain portions of the runner blades, paint was removed. There is a small area on both the top and the bottom surface at the leading edge near the periphery which seemed to be subjected to local cavitation. By slightly reshaping the leading edge so that it was sharper and making a very gradual transition from the nose to the original blade surface from 6 to 8 in. back from the leading edge, this local cavitation was largely eliminated. Efficiency tests are now in progress of being made on the units with current meters.

Wide Use of Kaplan Turbines

A. V. Karpov, designing hydraulic engineer, Aluminum Company of America, in his paper, "Low-Head Hydro-Electric Developments," called attention to the rapid progress that has been made abroad in developing the theory of low-head developments that has resulted in a wider use of Kaplan turbines. Starting with the general idea of francis, propeller and Kaplan turbines in low-head developments, the important points were discussed with respect to cavitation and pitting, modern design theories, design of propeller and Kaplan turbines and the research requirements and practice. Practical application of the theories was demonstrated by a table of projects, and the tendencies to extend the use of Kaplan turbines to lower- and to higher-head plants were discussed.

Tendencies in the use of Kaplan turbines are indicated by such installations as Vargon in Sweden, where two 15,200-hp. units are being installed to operate under a 14-ft. head; Safe Harbor development in the United States with units rated at 42,500 hp. under a 55-ft. head and the Shannon River development in Ireland where a 38,600 hp. unit is to be installed for a maximum head of 106 ft.

HYDRAULIC TURBINE AND PUMP COMBINED IN A SINGLE UNIT

By F. A. ALLNER*
General Superintendent
Pennsylvania Water and Power Company

IN PUMPED - STORAGE hydro plants installed up to the present time the turbines have served the single purpose of driving generators, separate pumps being used to do the pumping. It has been quite common practice to use the generators as motors to drive the pumps, although in some installations the pumps with their motors have been made independent units.

The proposal is now made that the units serve the dual purpose of turbines and pumps, these installations employing the same units as turbine-generator and motor-pump sets. They will be especially adapted to hydro plants where the increment cost of generating and transmitting capacity is lower than that of equivalent steam capacity and where a substantial overlapping of heads at hydro plants can be readily arranged.

The practice of storing water by pumping into specially constructed reservoirs for the purpose of producing peak power, started over thirty years ago. Compared with electric storage batteries or the storage of energy in heat or pressure accumulators, the pumped storage of water shows greater flexibility and is more economical per unit of stored energy, although the efficiency of conversion is lower than that of other means of storing energy.

The maximum over-all efficiency of a pumped storage plant in which each element is designed to do its respective duty in the most efficient manner is approximately 65 per cent, obtained as follows:

		Per Cent Efficiency
A.	Transmission from thermal plant to low tension bus of hydro plant	96
B.	Driving motor at unity power factor	97
C.	Average pump efficiency	85
D.	Slope of pond, head loss through racks, etc., when pumping	98
E.	Slope of pond, head loss through racks, etc., when generating	99
F.	Turbine	90
G.	Generator	96
H.	Transmission from hydro plant to low-tension bus of thermal plants	96
	Product of all efficiencies, *A* to *H*	63.7
	Product of all efficiencies, *B* to *G*	69.0

Pumping efficiencies of approximately 60 per cent can be obtained by operating in the reverse direction, but at the same speed and head, certain types of turbine runners which were originally designed to function only as waterwheels. Substituting in the tabulation a pump efficiency of 60 per cent, the over-all efficiency of conversion with a dual-use equipment is reduced to 45 per cent.

However, at pondage equipped run-of-river plants, that have a pronounced low-flow stage, the number of days on which operation under the regenerative cycle is necessary will be relatively small. Consequently, the loss of efficiency due to the use of the turbine unit as a pump instead of a specially designed pumping unit will not be a very important factor.

The best efficiencies for centrifugal pumps are between 85 and 89 per cent. Although apparently only 5 per cent less than best turbine efficiencies, when measured in terms of losses the best pump has from 50 to 75 per cent greater losses than the best turbine.

A centrifugal pump that has its best efficiency under certain conditions of head, speed and discharge for which it is designed, can be made to function as a turbine at the same head and will show the same efficiency, though at reduced speed and discharge. Fig. 1 shows the characteristic curves obtained from tests on a single-stage, 125-hp. circulating pump. The efficiency curves

*Abstract from a paper, "Economic Aspects of Water Power," presented at the Middle Eastern District meeting of the American Institute of Electrical Engineers, Baltimore, Md., Oct. 10 to 13.

Fig. 1—Characteristic curves of a single-stage pump operated as pump and turbine

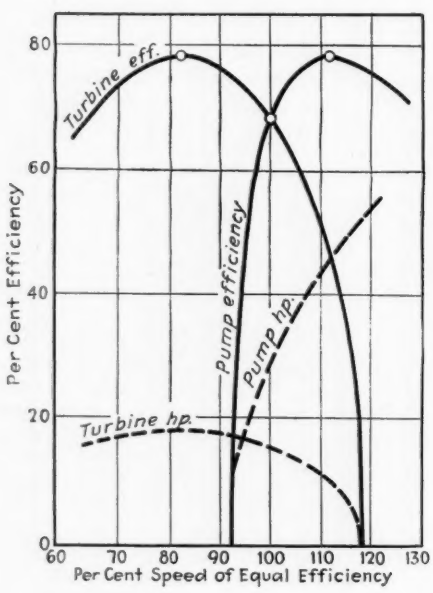


Fig. 2—Turbine and pump characteristics of a francis runner

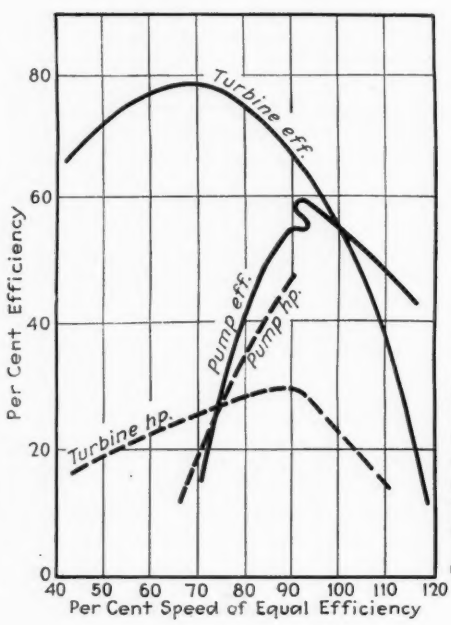
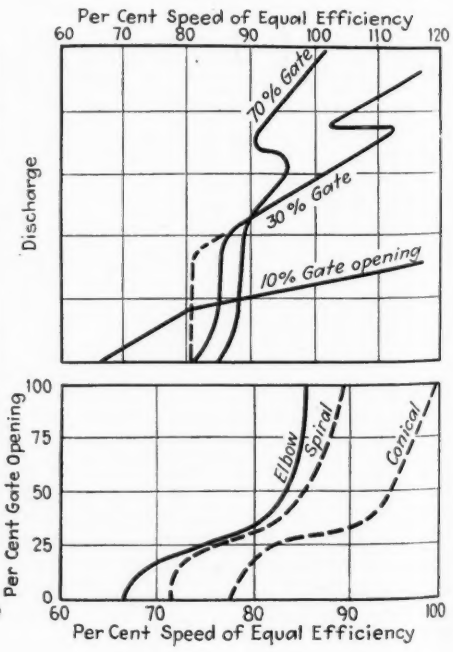


Fig. 3—Speed of impending delivery at various gate openings of a francis runner operating as a pump

Fig. 4—Speed of impending delivery of a francis runner operating as a pump in combination with three types of draft tubes



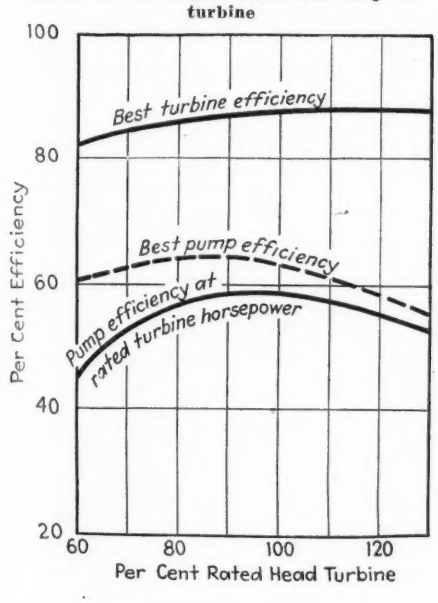
intersect at a point approximately 10 per cent below that of best efficiency.

For an installation where the hours of pumping and of generation are approximately equal, synchronous speed of normal operation for this type of runner should be in the vicinity of a point where the efficiency curves intersect. There is a certain risk, however, in lowering the operating speed materially below that at which the runner has best pump efficiency. With only a few per cent reduction in speed, or an equivalent increase in head, the efficiency will drop off rapidly and the runner will stop pumping. In Fig. 1, the latter point, usually called speed of impending delivery, lies only about 7 per cent below the speed of equal efficiency.

Another drawback of employing this type of runner for dual use is indicated by the relation of horsepower input for pumping to horsepower output for generation. At best, a runner of the characteristics, Fig. 1, may be considered for dual-use operation only under certain special conditions where the hours of pumping under average conditions will greatly exceed the hours of generation. For example, at some of the existing seasonal pumped-storage plants, a motor-pump set may be use as a generator at from 25 to 50 per cent of its rated motor input and at an efficiency of around 50 per cent on some rare occasions of sharp seasonal peaks of short duration. It would contribute whatever turbine output it could as so much additional firm peak capacity to the system, at practically no additional cost.

The modern type francis runner with its short, sharply reduced and warped water passages is not well suited for regenerative operation, as is indicated by the curves in Fig. 2. While the maximum efficiency of this turbine runner appears no higher than that of the centrifugal pump, Fig. 1, the test results, Fig. 2, were obtained from a small model, whereas the values of Fig. 1

Fig. 5—Turbine and pump characteristics of an adjustable-blade Kaplan turbine



In pumped-storage hydro-electric plants the turbines and the pumps have been separate units, each designed for the service that it was to perform. It is now proposed for certain conditions to use dual units to reduce plant-equipment costs. When power is to be generated the units will operate as turbine-driven generators that will be reversed to operate as motor-driven pumps during pumping periods

▼

were obtained from a full-size installation. Normal synchronous speed of a modern high-specific-speed francis runner lies usually in a range somewhat below the speed of impending delivery when operating the same runner as a pump against the same head.

The tests on this type of runner covered a wide range of conditions as to speed, head and gate opening, in combination with three types of draft tubes, elbow, spiral and straight conical. Some of these test results are shown in Figs. 3 and 4. There was a considerable spread in the speed of impending delivery, as well as in the speed of best pump efficiency for the different types of draft tubes.

With the elbow tube, the runner commences to pump at a much lower speed than with the conical tube. The maximum pumping efficiency with the elbow tube was several per cent lower than with the other types of tubes, but at a lower range of speed. Reduced gate openings have the effect of materially lowering the speed of impending delivery for all types of draft tubes.

There is some reasonable expectation that the francis type runner can eventually be developed for dual use at synchronous speed, especially for medium-head installations, without appreciably increasing the cost of equipment or lowering the turbine efficiency.

Among the types of turbine and pump runners available, the propeller turbine, particularly the Kaplan adjustable-blade type, seem to offer the greatest flexibility for dual use. Fig. 5 shows the efficiency curves of a 16-in. model over a range of 60 to 130 per cent of rated turbine head. Over this whole range of operation, the efficiency of the model drops only slightly below 60 per cent, the maximum being 65 per cent. The test results were obtained in the low-head laboratory.

Although these efficiencies checked closely with the test results obtained in the high-head laboratory, certain practical limitations were set by cavitation. At operating heads below 50 ft., this will probably not be a serious drawback, especially if serial plants on the same river are laid out with a substantial overlap of head.

Certain features influencing the extent to which hydro regeneration will be economical are: relation of deficiencies in flow to duration of high-flow stages, amount of pumping power required and number of pumping hours during each cycle, efficiency of regenerative conversion, overlap of heads and cavitation limits, and relation of increment cost of additional hydro capacity (including transmission and tie-in investment) to increment cost of steam capacity.

Aside from these considerations, any one of which may control the upper limit at which regeneration ceases to be profitable, there is one additional factor that will in many instances set a definite limit on the regenerative cycle, namely, the amount of pondage available.

The ideal condition would be two large lakes, that contain in the first foot or so of storage a volume equal to many times the minimum natural inflow. This volume can then be shifted daily from the upper to the lower level and back again without any appreciable drawdown in the upper, or rise in the lower, level.

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Volume of Tanks

By C. R. CHADBOURNE

(The following elementary instructions for computing the capacity of square and conical tanks are a continuation of Mr. Chadbourne's article "Figuring the Capacities of Tanks and Boilers," which appeared in the September number of POWER.—ED.)

If a tank is square instead of circular, we measure the length, breadth and height in inches, multiply these numbers together and divide by 231 to find the number of gallons.

Examples: 6. How many gallons will a tank 8 by 10 by 6 ft. hold? *Answer:* 3,590 gal. A rough and ready method of finding the number of gallons a tank or boiler will hold is to find the number of cubic feet and multiply by 7.5. This gives a result which is nearly correct, for there are nearly 7½ gal. in a cubic foot.

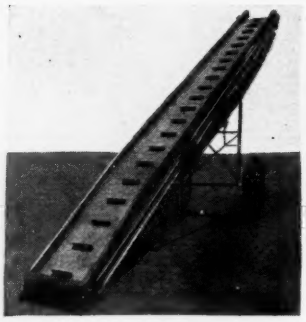
7. Find roughly the number of gallons in a tank 6 by 8 by 8 ft.? *Answer:* 2,880 gal.

Tank With Sloping Sides

For a tank with sloping sides we shall give only a rough and ready method which gives a result slightly too large, but near enough for most practical purposes. The top and bottom of such a tank have different areas. **Find these two areas, add them and divide by 2. Multiply this result by the height of the tank.**

8. Give roughly the capacity of a circular tank with sloping sides, the diameter of the top being 8 ft., the diameter of the bottom 10 ft., and the height 8 ft. *Answer:* 3,865 gal.

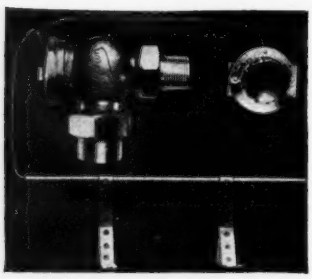
WHAT'S NEW IN PLANT EQUIPMENT



Portable Conveyor

This improved portable conveyor incorporates fixed steel retaining sides extending the entire length of the conveyor to prevent lumps from spilling over the sides of the belt at any point. Foot end has been improved to keep material away from the return run of conveyor belt. New arrangement of foot end plate permits convenient use of machine without plate, when desired. Twenty one foot centers with 18- or 24-in. belts. Idlers all-metal troughing type with anti-friction roller bearings. Bearings bronze-bushed. Variable discharge height. Unit illustrated may be modified.

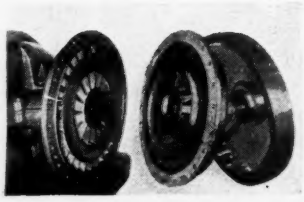
Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill.



Room Temperature Thermostatic Radiator Valves

Fulton "Sylphon" automatic radiator valves are made for both exposed and concealed radiation. No. 885 is for exposed, in the angle type, and No. 886 in the globe; No. 895 angle for inclosed and No. 896 for globe. The valves replace ordinary radiator valves and require no piping, wiring or auxiliary equipment. Thermostat member is seamless metal bellows filled with liquid sealed in vacuum. Temperature variation between 60 and 90 deg. may be controlled in the exposed type, and 40 to 90 deg. F. in the inclosed.

Fulton Sylphon Co., Knoxville, Tenn.



Hydraulic Coupling

This hydraulic coupling for use between fans and motors, eliminates constant speed disadvantage of squirrel-cage motors for fan application. Coupling gives infinite number of fan speeds, from close to motor speed down to about 20 per cent of motor speed. Motor can be started under practically no-load conditions, and coupling protects fan wheel against rapid acceleration strains when motor is thrown directly across the line. Three essential elements include impeller on the driving shaft, runner on driven shaft, and a quantity of working fluid. Operating speed varied by adding or removing oil automatically. Coupling floats on extensions of fan and motor shafts. No bearings in coupling and no contacts with stationary parts. Introduced by Hydraulic Couplings, Inc. Sold by:

American Blower Corp., Detroit, Mich.

Rubber Paints

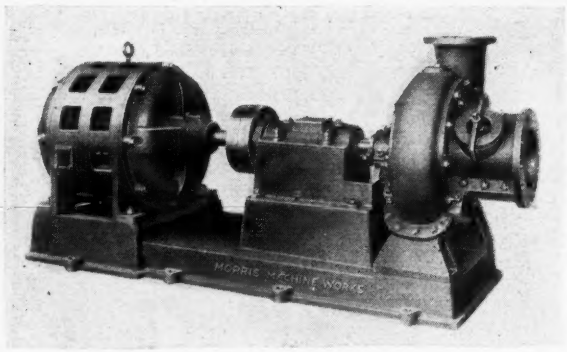
"Acidseal" paints have a commercial form of rubber isomer as a base, which increases adhesion, dries in one hour to a hard, firm film, yet retains rubber's elasticity and its chemically resistant properties and minimizes corrosive action of acids, alkalies and chemical fumes. Not water-absorbent.

B. F. Goodrich Rubber Co., Akron, Ohio.

High Water Alarm

Class 9036H1 high water alarm is for use over sump or open tanks and sounds a warning when liquid reaches a dangerously high level. It consists of single-pole pressure switch, transformer and signal bell, wired in one unit and mounted on a 1-in. pipe. Rising column of liquid in pipe exerts air pressure on diaphragm of switch, closing contact and ringing bell. Signal continues until high liquid level has been reduced to safe limit.

Square D Co., Industrial Controller Division, Milwaukee.



Non-Clogging Centrifugal Pump

This non-clogging centrifugal pump for handling pulp and similar material of heavy and light consistency has suction nozzle, impeller and pump passages, all of special form to secure uniform conversion of velocity of the material to pressure with minimum friction and slippage. Various designs of impellers are available. Balance of end thrust, adequate support for the heavy shaft, convenience of access to the pump interior for inspection and cleaning, and economy of maintenance have also been achieved in the redesign.

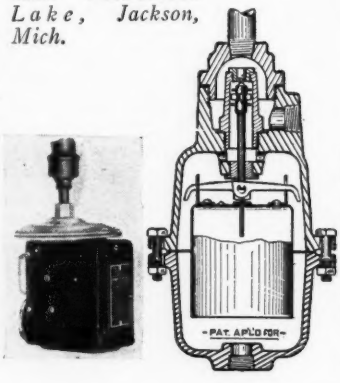
Morris Machine Works, Baldwinsville, N. Y.

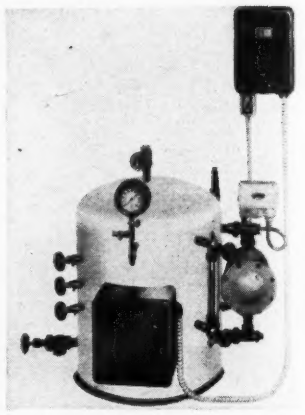
Steam Trap

This inverted bucket type steam trap is first of a line for both high and low pressures. Inlet is at bottom, outlet at top, with optional outlet at right.

When side outlet is used, valve and seat can be inspected or replaced without disturbing piping. Features include: high valve-opening leverage, wide opening between valve and seat, rotating valve action for self-seating, all parts non-corrosive, bucket and valve have vertical movement only and valve closes at bucket speed.

Spade-Thayer Co., 307 Bird Ave. Vandercook Lake, Jackson, Mich.

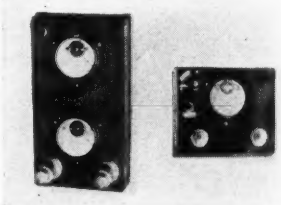




Electric-Heated Steam Boiler

"Comm-O-Lectric" electric-heated full-automatic steam generators for producing process steam in small or moderate quantities and at pressures from 1 to 200 lb. gage are available in six standardized models, 7½, 15, 30, 45, 60 and 90 kw. They conform to all requirements of A.S.M.E. or Massachusetts Boiler Construction Codes. One- to 6-kw. units are also available.

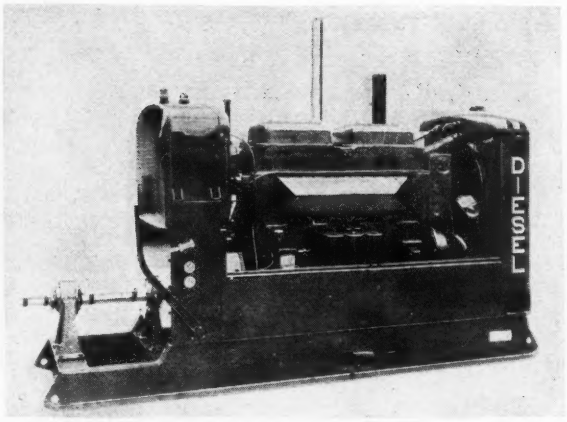
Commonwealth Electric & Mfg. Co., 105 Boston St., Boston, Mass.



Midget Voltmeter

Sullivan "Migit" volt-ammeters are self-contained units small enough to be carried in an overall pocket. No shunts necessary, and instructions for use printed on back of each instrument. Maximum voltage, either a.c. or d.c., is 600, and maximum amperage 300.

Sullivan Machinery Co., 400 North Michigan Ave., Chicago.



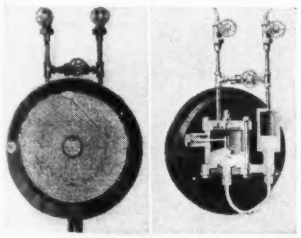
Diesel Engine

"Caterpillar" D-9900 industrial engine is adaptation of the tractor unit. It has a 6½-in. bore, 9¼-in. stroke, and is governed at 700 r.p.m. to develop better than 85 hp. It has four cylinders, is four-cycle, and uses solid-injection fuel system in its precombustion chamber. Fuel injectors have single orifice. The starting mechanism is a small two-cylinder four-cycle gasoline engine mounted on the side of the diesel itself. Exhaust gases of this starting engine warm the diesel intake for even starting. Starting energy imparted to diesel through clutch and Bendix drive to diesel flywheel.

Caterpillar Tractor Co., Peoria, Ill.

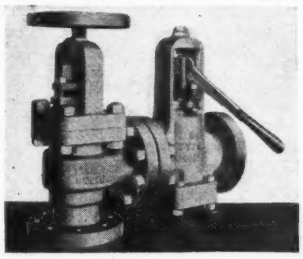
Mechanical Flow Meters

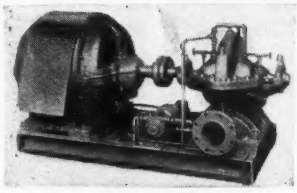
Simple direct lever-actuating mechanism, large float, and pressure-tight bearing with grease reservoir, series of range tubes that permit changing range of meter without disturbing orifice and ease of cleaning manometer without altering calibration are features. Instrument mechanism built into die-cast aluminum case. Records on a square root chart or an evenly



divided chart. All models use 12-in. charts. Either hand wound or electric chart drive and variety of chart speeds. Some models incorporate automatic recording planimeters and totalizers. Control models in both single and duplex forms have been developed. Working pressures up to 1,000 lb.

Brown Instrument Co., Philadelphia, Pa.





Centrifugal Pumps

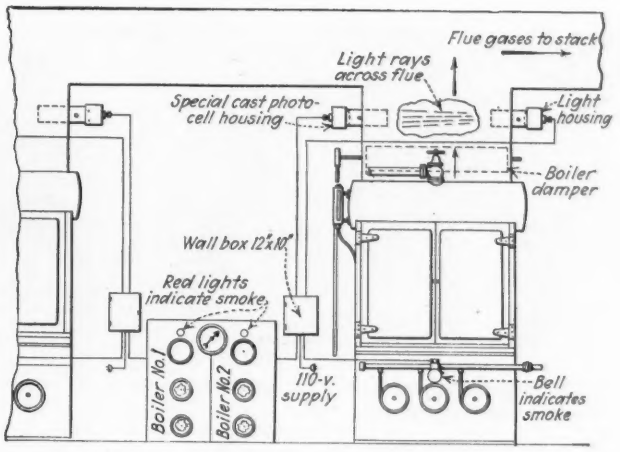
This self-contained automatically primed centrifugal pumping unit comprises an electrically driven high-efficiency ball-bearing centrifugal pump, mounted with its motor on a fabricated-steel bedplate, together with a Monobloc priming unit of the wet-vacuum type, controlled by an electric pressure switch. Priming pump, or evacuator, is an adaptation of the "Hytor" pump, licensed to Worthington. Units available with Worthington Type R, U, L and F centrifugal pumps up to No. 6 size, and shortly with any type or size of Worthington centrifugal pump. Claimed to make possible effective remote control whenever suction lift exists, and to eliminate wet and dry-pit installations, and foot valves.

Worthington Pump & Machinery Corp., Harrison, N. J.

Clutches

"Pullmore" multiple-disk friction drive unit made in six standard sizes, single or double, from ⅜ to 2¼-in. shaft diameters and 2-25 hp. at 500 r.p.m.

Morse Chain Co., Ithaca, N. Y.



Tandem Boiler Blow-Off Valves

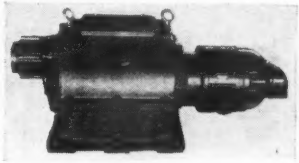
Type D plug, and Type E angle tandem boiler blow-off valves for pressures from 250 to 400 lb. embody same principles as Type C valve. "Cochrome" bodies for pressures up to 250 lb. and cast-steel bodies for pressures up to 400 lb. Either may be used independently to supplement any existing valve, or together in new service. Plug valve is lifted clear of seat before turning begins. Lifting operating handle causes cam to press valve inwardly away from seat, while at the end of rotation upon lowering handle valve is again seated by a spring and by internal pressure. In Type E, wire drawing and scoring of disk and seat claimed avoided by providing underneath the disk proper a close-fitting skirt, which fills seat opening and prevents appreciable flow until disk has been raised clear of seat. Disk and seat of Nitralloy, replaceable.

Cochrane Corp., 17th St. below Allegheny Ave., Philadelphia, Pa.

Motorized Speed Reducer

Totally inclosed triple-reduction unit (shown) has speed ratio of 312.2-1. Motor shaft (extends into reducer housing) operates at 1,165 r.p.m., and low-speed shaft at 4.75 r.p.m. Claimed to provide increased efficiency and compactness, reduce floor space and eliminate high-speed motor-shaft coupling. Roller bearings and continuous-tooth herringbone gears used. Gears run in oil. Tabulated ratings allow for 100 per cent momentary overloads.

Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill.



Smoke Indicator

"Bell-Lite" photo-electric smoke indicators ring a bell and flash a light when smoke issues from boiler or stack, thus giving a visible and an audible signal, simultaneously. Chart recorder may be attached readily.

Parry Engineering Co., 135 E. 42nd St., New York, N. Y.

Motor-Reducer

(Corrects October item)

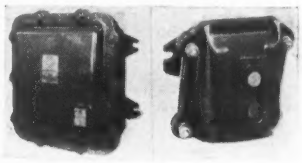
"MotoReduceR" combination horizontal motor and speed reducer unit solid, compact. Designed to avoid misalignment of parts. Available in single, double and triple types with ratios up to 450 to 1, and with standard open type or totally inclosed fan-cooled motors, polyphase and single-phase. Also available with d.c. motors up to 10 hp.

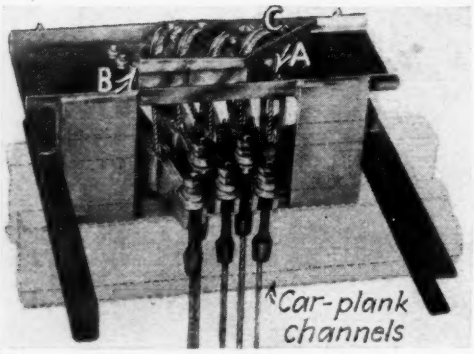
Philadelphia Gear Works, Inc., Philadelphia, Pa.

Explosion-Resisting Linestarter

Developed for use in Class I, Group D, hazardous locations as described in National Electric Code (where highly flammable volatile liquids or gases are manufactured, used or handled). Consist of standard linestarter units mounted in heavy cast-iron cabinets with wide flanges. Built with separate mounted or built-in push-button.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

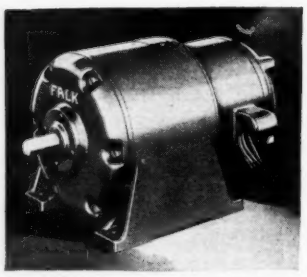




Automatic Equalizer for Compensating Ropes

This type of compensating-rope equalizer has rope shackles connected to the end of horizontal equalizing bars, which have their opposite ends pivoted between two channels as in the figure. Near the center of each bar is a sheave from which it is supported by an equalizing rope deadended at *A* and *B*, and also passing around fixed sheaves *C*. By this arrangement load will be distributed equally between the different ropes at all times. Any change in length of one or more of the ropes will immediately be compensated for by movement of the bars to equalize their loading.

Evans Elevator Equalizer Co., 70 East 45th St., New York City.



Motor-Reducer

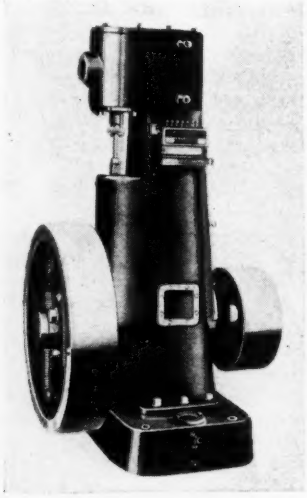
Three styles. Have gear housing as a support for motor to assure necessary rigidity. In integral type, motor end bell removed and motor close-coupled through bayonet-type joint to gear case. In flexible type, round frame-type motor used and end bell retained. In all-motor type, any standard horizontal motor may be used, being connected through Falk flexible coupling to reducer housing. Integral illustrated. All three types available in hp. from ¾ to 75, with ratios from 4.6 to 288. Non-planetary, helical-type gears used with oversize ball bearing. Efficiency claimed minimum 97 per cent.

Falk Corp., Milwaukee, Wis.

Oilless Bearings

For submerged operation without lubrication in any solution not harmful to rubber, "Parock" graphite-impregnated rubber bearings can be obtained as complete bearings or in solid square or round bars from 1 in. up to 36 in. O.D. in ¼-in. increments. Maximum atmospheric and bearing temperature is 250 deg. F., thickness of bearing under ¾ in. I.D. is ⅛ in., over is ¼ in. Weight of material, 1 oz. per cu.in.

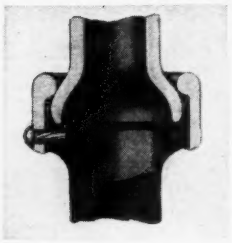
The Manhattan Rubber Mfg. Division of Raybestos-Manhattan, Inc., Passaic, N. J.



Steam Engine

Troy-Engberg Type E engines now have a new watershed partition between cylinder and crankcase. No part of it comes in contact with the piston rod. Special drains provided from piston rod and valve stem stuffing boxes to prevent water from cylinder getting into oil reservoir in engine base. Engines available with either flat or piston valve on 10-in. stroke size; both types of valves will soon be available on all sizes. Manufacturer will introduce a 12-in. stroke Type E vertical engine which will have a rating of 160 b. hp. at 300 r.p.m. for full load, 24-hr., continuous service, and a maximum speed of 325 r.p.m. Troy single-cylinder engines from 1 to 225 hp., and duplex engines from 2 to 450 hp. in both vertical and horizontal types are available. All are heavy-duty machines.

Troy Engine & Machine Co., Troy, Pa.



Above—Ball swivel action of "Square Gee" pipe hanger at right

Pipe Hanger

"Square Gee" adjustable ball swivel pipe hangers have ball-and-socket joint for ring flexibility. Malleable iron hangers constructed so that swivel may be turned on threaded suspension rod for vertical adjustment. End of hinged arm forked and straddles ledge projecting from socket. Held in position by U strap. Hinge offset to provide hook to support pipe hanger is closed. Fig. 351 hanger is solid type; Fig. 352 hinged-type.

Grabler Mfg. Co., Cleveland.

Indirect Water Heater

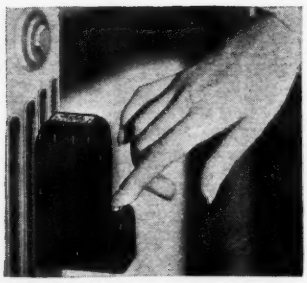
"B & G Booster" is an electrically-operated circulator with positive centrifugal pump action, for hot-water heating. By increasing circulation it provides quicker heating with lower boiler water temperature, permits smaller pipe, and corrects installations where pipes are undersize. Booster is an element of triple-duty indirect water heater designed for use on all automatically-fired hot water-heating boilers.

Bell & Gossett Co., 3000 Wallace St., Chicago, Ill.

V-Groove Pulley Drive

"Day-Steel" single and multiple V-groove pulleys for use with Dayton cog belts, for ratings of 7½ hp. and below, have been announced. They are heavy-gage pressed steel, welded at rim and at web, and assembled with a new design hub. Engineering and price data in Bulletin No. 110.

Dayton Rubber Mfg. Co.



Temperature Control Air Valve

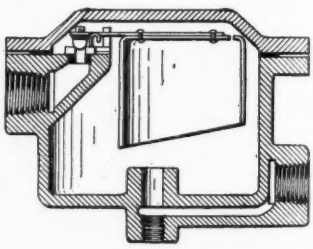
Room temperature control air valves for one-pipe steam heating systems replace the usual air or vacuum valve. The rotary adjustment provides selective temperature between 60 and 80 deg. F., which the valve holds to within 2 deg. Can be used with oil or gas burner systems. Control element is bimetallic, and other parts are of Textolite, brass and german silver.

Dole Valve Co. 1913 Carroll Ave., Chicago, Ill.

Elevator Bucket

For heavy-duty work. Known as Style "AAP," made in all popular sizes, has heavy back and lip, reinforced corners and reinforcing ribs, bead around ends. Made of "Promal."

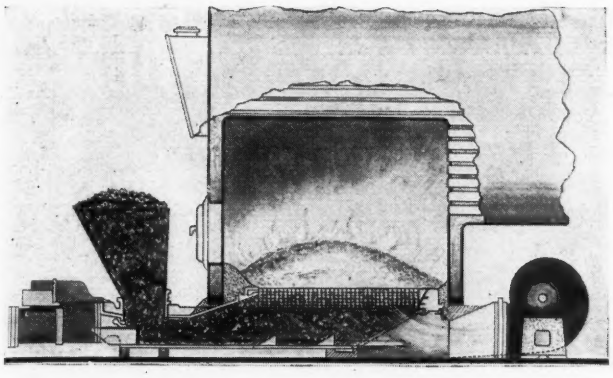
Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill.



Inverted-Bucket Steam Trap

"K-Master" Midget modernized inverted-bucket steam traps have but one moving part. Side inlets and outlets avoid cooling leg. Water passage is simple, and large-size valve provides increased capacity. No mechanism is attached to cover. Compound rocking fulcrums on a single lever avoid fixed pivots. At differential pressure of 20 lb., water capacity is 990 lb. per hr., which, at differential pressure of 150 lb., decreases to 600 lb. of water per hr. Inlet and outlet are ½ in.

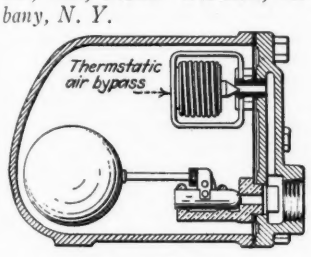
Kaye & MacDonald, Inc., 94 Franklin Ave., West Orange, N. J.



Hydraulic Ram-Type Underfeed Stoker

In "Albany" stokers, hydraulic ram forces fuel into furnace without gears or other complicated parts. Hydraulic power unit, consisting of motor pump and fan, can be placed where most convenient. Motor-driven oil pump on same shaft with forced-draft fan provides pressure which operates hydro-motor ram. Hydraulic principle provides an extremely wide range of fuel feed adjustment without stopping stoker or shifting gears or changing length of ram stroke or interfering with fuel distribution.

Consolidated Car Heating Co., Inc., Stoker Division, Albany, N. Y.



Float Trap

Sarco FT-O float trap with thermostatic air bypass is adapted for risers, small mains and unit heaters. It has integral thermostatic air vent inside the trap, all working parts mounted on cover and fully exposed by removing trap body, inlet and outlet on cover a vertical distance of only 2⅝ in. apart for horizontal piping, and ease of installation where headroom is limited. Spherical valve head for maximum capacity. Inlet and outlet trappings are ¾ in., but can be furnished in 1-in. sizes. Discharge capacities at low pressures, for a differential of ½ lb., is 750 lb. per hour, for a differential of 10 lb., 4,500; for high pressures, and differential of 10 lb., 1,100 lb. per hour, and differential of 60 lb., 2,800 lb.

Sarco Co., Inc., 183 Madison Ave., New York City.

Refractory

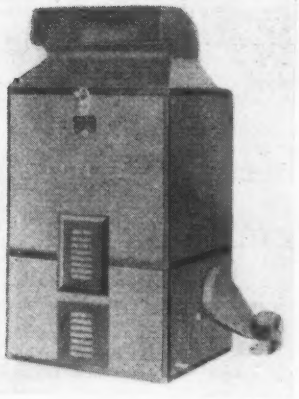
"Cast-Refract" can be cast or molded on the job to any desired shape or form. Air-sets quickly with high structural strength, and can be put under full heat within 24 hr. Shipped dry. Adapted for casting special shapes, boiler furnace and coke oven door linings, and for other more or less intricate refractory construction. It produces a monolithic structure that is air-and-gas-tight, free from shrinkage, highly resistant to spalling, and with refractory properties up to its temperature limit 2,600 to 2,800 deg. F.

Quigley Co., Inc., 56 West 45th St., New York City.

Horizontal Duplex Steam Pump

Designed and fitted for handling either water or chemical solutions in valve plate, turret and pot valve types. Horizontal duplex steam pumps have stainless steel drop-forged valves. Valve plate type units have capacities from five to 320 g.p.m. at pressures up to 250 lb. per sq.in. Turret-type pumps available for capacities of 150 to 840 g.p.m. for discharge pressures to 75 lb. per sq.in., and with capacities of 100 to 500 g.p.m. for pressures up to 200 lb. per sq.in. Pumps of pot valve type come in three styles: For pressures up to 500 lb. per sq.in. with a capacity of 40 to 96 g.p.m. they have special steam end. For boiler feed service, capacities of 15 to 760 g.p.m., and discharge pressures to 300 lb. per sq.in., standard steam ends are utilized, and liquid ends are of the outside end-packed-plunger pot valve pattern. For pressures up to 500 lb. per sq.in., and capacities of 140 to 1,800 g.p.m., cylinders are fitted with bronze liners and liquid piston rods of stainless steel.

Worthington Pump & Machinery Corp., Harrison, N. J.



Gas-Fired Air Conditioning Warm Air Furnace

Niagara 110 has units built in two compartments, the upper containing the heat generating equipment, radiating section, controls and humidifier, while the blower and filter equipment blower and filter. Unit is entirely automatic, and provides either forced air or gravity circulation.

Forest City Foundries Co., 2500 West 27th St., Cleveland.

Built-In Capacitor Motor

"Red Band" fractional-horsepower, built-in capacitor motors are claimed compact and neat in appearance. Horizontal unit is shown. Also manufactured in rigid or rubber-mounted vertical types with register, flange and other mounting, and also as stators and rotors for built-in equipment. Sizes vary from ⅛ to ⅓ hp. Units are 110-volt, single-phase, 60-cycle, 1735-r.p.m. full-load speed.

Howell Electric Motors Co., Howell, Mich.

Sheet Packing

"Garlock" 660 sheet packing for gasoline, oil and water combines granulated cork with tough paper fiber. Comes in all standard thicknesses from 0.010 to ½ in. In thicknesses less than ⅛ in., it can be supplied in rolls 36 in. wide or in sheets. In ⅛ in. and greater in thickness, it is furnished in 36 in. sheets.

Garlock Packing Co., Palmyra, N. Y.

Centrifugal Pump

"Electropump" is the small, efficient, low-cost, centrifugal unit for small and moderate capacities for operation against heads up to 150 ft. or 65 lb. pressure in a single-stage unit, and twice the head or pressure when furnished with two stages in series. It is used for circulating hot and cold water or brine, for water supply systems and booster service, and similar work. Motor and pump are built into one unit to reduce rotating parts. Couplings eliminated, and no special foundation required. Unit consists of single-stage, single-suction, fully bronze-fitted pump with close-coupled motor. Impeller of inclosed type, mounted, keyed and locked on extension of motor shaft. Known as Type E, available in 1, 1½ and 2-in. sizes.

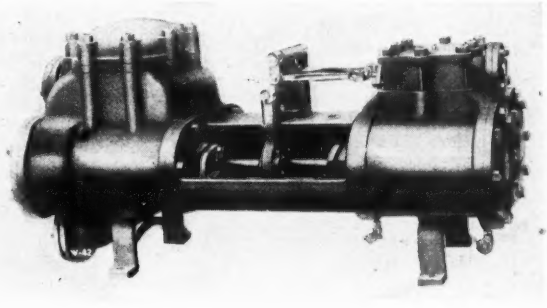
Lawrence Pump & Engine Co., Box 70, Lawrence, Mass.

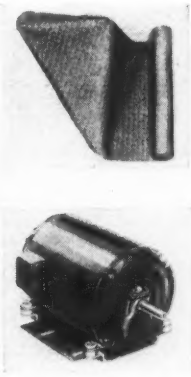
Portable Oil Filter & Motor-Driven Pump

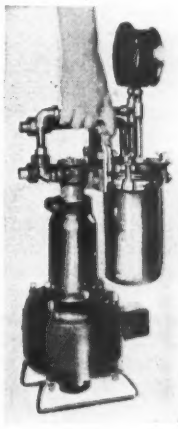
A portable combination oil filter and motor-driven oil pump for use with small gear-reduction units, engines, pumps, compressors and other machinery having oil reservoirs, where a permanent oil filtering system is impractical or too expensive, is now available. Pump suction is connected by flexible metal hose or regular piping to oil drain in the reservoir, and discharge is similarly connected to inlet. Operated from electric light socket. Time required for filtering depends upon oil condition, quantity and viscosity. Several sizes of units manufactured, ranging from 65 to 2,000 gal. per hr. Also available with friction or belt-driven pump instead of motor as illustrated.

William W. Nugent & Co., 410-412 N. Hermitage Ave., Chicago, Ill.

Right — Garlock packing. Below— Capacitor motor







POWER LINES

A.S.M.E. Annual Meeting, Power Show, Scheduled in December

THE technical program for the annual meeting of the American Society of Mechanical Engineers has now been practically completed, and papers of greatest interest to power engineers are listed below. The meeting will be held Dec. 5-8 in the Engineering Societies Bldg., New York City, at the same time the tenth National Exposition of Power & Mechanical Engineering will be held in the Grand Central Palace.

Two years have elapsed since the last exposition, and in the interim a number of changes and advances have of course taken place. Somewhat over 300 firms have already taken space. Several firms will illustrate the research that has been going on to develop the best materials to meet service demands of high pressure and high temperature in the modern power plant. Another will show by microscopic slides and micro-photographs, cultures, etc., just how slime is formed on condenser tubes and how to combat it effectively.

Automatic control will occupy an important place. One firm will show several new electrical devices for temperature control. Another will exhibit new optical pyrometers and a super-sensitive radiation tube that permits temperature recording of fast-moving objects. An interesting demonstration of the uniformity of bore in steel instrument tubing will be given under the microscope. New water-level indicators, high and low-water alarms, steam traps of improved design in operation, and a new expansion joint under accelerated test are a few of the attractions. The exhibits of piping and fittings, developed to meet the present demands of severe service, are expected to be of special interest to engineers engaged in power plant design.

Faced with the necessity of bringing their power plants up-to-date, executives and engineers of industrial establishments are expected to welcome the opportunity afforded by the Exposition to examine the many new designs, individually and collectively, before making their decisions. For this reason it is believed that the Show comes at a most opportune time.

The first Show in 1922 had an attendance of 47,000. The attendance increased with successive years and was over 130,000 in 1930. It is expected that the attendance this year will measure up to that of the immediate predecessors.

In the meeting program are three sessions arranged by the Applied Mechanics Division as a Symposium on Working Stresses that promises to be of unusual value to designing engineers. The first session covers strength theories and fatigue, the second covers stresses due to the effects of high temperatures, while the third discusses stresses due to impacts, and closes with a summary of all the material presented, including suggestions on the choice of working stresses.

The Management Division leads all others in the number of sessions in which it is cooperating or sponsoring. This Division will sponsor three sessions of its own and is cooperating in two others. The Machine Shop Practice Division is sponsoring and cooperating in three sessions; the Railroad Division is sponsoring two sessions and cooperating in a third. The Iron and Steel Division is sponsoring and cooperating in three sessions. Other sessions deal with Power Test Public Hearing, Materials Handling, Industrial Power, Textile, Fuels, Hydraulics, Oil and Gas Power, Central-Station Power, Aeronautics, Mechanical Springs, Training for the Industries, Lubrication Engineering, Steam-Table Research, and Boiler Feedwater Studies.

For two years a series of talks has been given by Dr. S. Marion Tucker of the Polytechnic Institute of Brooklyn on "How to Talk with an Audience." This series will again be repeated at the Annual Meeting at 8:50 a.m. on three mornings.

Principal papers of interest to power engineers are:

Application of Creep Tests, G. H. MACCULLOUGH.
Factors Affecting Choice of Working Stresses for High Temperature Service, P. G. MCVETTY.
Metals at High Temperature—Test Procedure and Analysis of Test Data, ERNEST L. ROBINSON.
Public Hearing on Test Code for Centrifugal Compressors, Exhausters, and Fans. Pulsation in Air Flow from Fans and Its Effect on Test Procedure, H. F. HAGEN.
Influence of Bends in Inlet Ducts on the Performance of Induced-Draft Fans, L. S. MARKS, J. LOMAX, and R. ASHTON.
Observation of Liquid Water in Steam Passages and Means of Effecting Separation, C. C. THOMAS.
High-Pressure Steam-Generator Research, A. A. POTTER, H. L. SOLBERG, G. A. HAWKINS and P. A. WILLIS.
Progress Report of Power Division.
The Measurement of Metal Temperatures on the Heat-Receiving Side of Heat-Exchanging Apparatus, ARTHUR WILLIAMS.

COMING MEETINGS

10th National Power Show—Grand Central Palace, New York City, Dec. 5-10, during annual meeting, A.S.M.E. Conducted by International Exposition Co., Grand Central Palace, New York City. Charles F. Roth and Fred W. Payne, managers.

American Society of Mechanical Engineers—Annual meeting, New York City, Dec. 5-9. Secretary, Calvin W. Rice, 33 West 39th St., New York.

American Society of Heating & Ventilating Engineers—39th annual meeting, Hotel Gibson, Cincinnati, Ohio, Jan. 23-25, 1932. Headquarters, 51 Madison Ave., New York City.

International Acetylene Ass'n.—Annual convention, Penn Athletic Club, 18th St. & Rittenhouse Sq., Philadelphia, Pa., Nov. 16-18.

National Ass'n Practical Refrigerating Engineers—23rd Annual Convention, Sherman Hotel, Chicago, Ill., Nov. 1-4.

Stoker Development at Delray Power House No. 3, The Detroit Edison Company, PAUL THOMPSON and FRED S. CHATEL.
Progress Report of Fuels Division.
Problems of Modern Pump and Turbine Design, WILHELM SPANNHAKE.
Research Institute for Hydraulic Engineering and Water Power, HUNTER ROUSE.
Progress Report of Oil and Gas Power Division.
Progress Reports of Thermal Properties of Steam Research Committee.
A Study of the Data on the Flow of Fluids in Pipes, EMORY KEMLER.
Progress Report of Hydraulic Division.
Stresses in Boiler Tubes Subject to High Rates in Heat Absorption, WM. L. DEBAUFRE.
A System for Measurement of Steam with Flow Nozzles for Turbine Performance Tests, SANFORD A. MOSS and WISTAR W. JOHNSON.
Performance of Modern Steam-Generating Units, C. F. HIRSHFELD and G. U. MORAN.
Some Problems on the Lubrication of Vertical Journal Bearings, A. I. PONOMAREFF and E. D. HOWE.
Chemistry of Lubrication, W. F. PARISH and LEON CAMMEN.
Progress Report of Petroleum Division.

N.A.P.R.E. 23rd Annual Convention Now Being Held in Chicago

Nov. 1-4 are the dates for this year's convention of the National Association Practical Refrigerating Engineers, and the place is the Sherman Hotel, Chicago. Attendance in excess of that at any previous meeting is expected, and a complete program of technical papers, trips, and social features has been arranged. An educational exhibition will be included. Papers:

"Some Important Points for the Refrigeration Ice Plant Owner and Operator," W. E. Zieber, Research Dept., York Ice Machinery Corp.
"Header Arrangements for Evaporating Coils," H. C. Guild, A. M. Byers Co.
"Solid CO_2," Frank R. Zumbro, Frick Co.
"Packing House Refrigeration," Donald MacKinzie, Swift & Co.
"Conditions Favoring the Use of Booster Compressors," Harry Sloan, Vilter Mfg.
"Unit Coolers," George B. Bright, Geo. B. Bright Co.
"Dairy Refrigeration," H. S. Fielder, Cherry Burrell Corp.
"Comfort Cooling," M. G. Harbula, consulting engineer, Glen Ellyn, Ill.
"Electrical Demonstration," Westinghouse Electric & Mfg. Co.
Prize Winning Paper in the N.A.P.R.E. 1932 Contest.

N.A.P.E. in New York Celebrates Golden Anniversary

New York City, birthplace of the N.A.P.E., on Oct. 25, 1882, was again the scene of gay festivities Oct. 25, 1932. Celebrating this Golden Anniversary, the four sister associations of the metropolitan district assembled in the Hotel New Yorker for dinner, speeches, entertainment and general joviality. The arrangements for this party were made by the following officers of the Metropolitan District Committee: H. W. Wilds, Chairman; George Griffel, Secretary; F. McGonigal, Vice-Chairman.

Participating metropolitan associations were Greater New York No. 1, Phoenix No. 24, Brooklyn No. 41 and Stevenson No. 44. A feature of the meeting was the presence of nearly a dozen national past presidents.

Rex Plant Largest On a Passenger Ship

The Italian steamer *Rex,* which recently completed its maiden voyage from Genoa to New York City, contains the largest power plant of any of the passenger liners. Steam is supplied to the ship's turbines at 385 lb. pressure and 734 deg. F. from eight double-ended and four single-ended water-tube boilers fired by oil fuel. There are also two auxiliary Scotch marine boilers with three furnaces each. Four sets of Parsons turbines, with a designed output of 120,000 shaft horsepower and a normal output of 100,000 shaft horsepower drive the four propellers through 10-to-1 single reduction gears, giving the ship a designed speed of 27 knots. The main auxiliaries of the propelling plant are steam driven.

Seven auxiliary generating sets, with a total capacity of 4,620 kw., supply electric energy for practically all of the ship's services, such as illumination, ventilation, refrigeration, elevators, cooking, winches, etc. Three of these sets are 1,250-kw. turbine generators, which may be supplied with superheated steam or saturated steam from the main boilers, or steam from the two auxiliary Scotch boilers. Three diesel engine sets of 210-kw. capacity also provide auxiliary electric energy, and one emergency diesel set is installed on deck.

The ship's maiden voyage was unfortunately marred by an accident to the auxiliary generating plant, which caused a delay for repairs at Gibraltar. Priming of the boilers caused slugs of water to pass over to the auxiliary turbines, damaging the blading of the two turbines in operation. As the remaining auxiliary generating sets did not have sufficient capacity to supply power to the ship's services, it was decided to lay over at Gibraltar rather than proceed with only part of the services operating. The two crippled turbines were opened, the damaged blading removed from the turbine rotors, and the turbines put back into service.

Although these auxiliaries operated at greatly reduced load for the remainder of the trip, nevertheless, they, together with the uninjured turbine, had sufficient capacity to provide power for ship's services. An average speed during the remainder of the trip of 25.4 knots was maintained.

N.D.H.A. Charters First Regional Chapter

A charter for the first regional chapter of the National District Heating Association was presented to Davis S. Boyden, chairman of the chapter and head of the Boston Edison Company steam heating service department, at the initial organization meeting held at the Engineers Club, Boston, Sept. 28. There were 72 members registered at the two sessions held in the afternoon and evening, the latter session consisting of a dinner meeting. According to present plans, semi-annual meetings will be held with the objective of studying and fostering developments in this rapidly growing field, coordinating the local angle with the broader scope of research work and promotional effort carried on by the national organization.

Other elective officers with Mr. Boyden were: G. K. Saurwein, vice-chairman; R. M. Nee, secretary; A. J. Glossa, treasurer and an executive committee of three members, H. W. Coombs of Boston, E. D. Learned of Worcester and C. F. Mosher of Turners Falls, Mass.

V.D.I. Cancels

The Verein deutscher Ingenieure (V.D.I.) will not hold its usual annual meeting this year. In its place a Scientific Meeting was held at the Technical University of Berlin Oct. 15-16. The program included the following papers:

"Determination of Stress Distribution in Construction Parts by Measurements of Extension," Prof. Dr. F. Rötcher.
"Measurement of Vibration—Its Present State and Future Aims," Dr. E. Lehr.
"Position of Refrigeration Engineering in Food Economy," Prof. Dr. R. Planck.
"Present State of Research in Clipping Materials," Prof. Dr. G. Schlesinger.
"Significance of Physical and Chemical Properties of Dust in Industry," Dr. R. Meldau.
"Elasticity of Industrial Net Costs During Periods of Crisis," Prof. Dr. H. P. Brasch.
"Scientific Management in the Production of Articles Used in Daily Life," Dr. O. Kienzle.
"Present State of Research in Heat Transmission," Prof. Dr. E. Schmidt.
"Recent Opinions and Tests Regarding Phenomena on Vaporization and Condensation," Prof. Dr. M. Jakob.
"Recent Results of Research Regarding the Process of Injection in Diesel Engines," Prof. Dr. A. Nägel and Dr. O. Holfelder.
"Engines and Employments," Prof. Dr. E. Heidebrock.
"Some Notes on Recent Results Regarding Flow Research," Prof. Dr. L. Prandtl.
"Forced Firing of Boilers in Conjunction with Gas Turbines," Dr. W. G. Noack.
"The Noise Problem Considered from the Standpoint of the Engineer," Prof. Dr. K. W. Wagner.

Fire Destroys Turbine Room At Brussels Station

A fire at the Brussels (Belgium) Station, started by the ignition of oil and simultaneous failure of a screwed plug in the oil pressure system of one of the turbines, burned the turbine room roof causing it to collapse into the turbine room, and resulting in complete shut down of the station. This station, erected in 1905, contains nine 6,000-kw. turbines and supplies a peak winter load of 40,000 kw. to the business section of Brussels. At the time of the accident, however, the load was light.

According to the *Engineer* of Oct. 7, the first indication of trouble was noticed by an operator who saw that some oil on the high pressure pedestal of one of the turbines had ignited, probably from a short circuit in the wiring to the governor control motor. Before the operator could approach the unit a screwed plug in a lubricating oil line under 60 lb. pressure blew out and a jet of flaming oil shot upwards, setting fire to the wood and steel roof some 50 ft. above. Heat from the flame and the shower of burning oil prevented approach, and the roof was quickly ablaze from end to end.

In one hour the fire was under control, and the damage to the station confined to the turbine room. Three hours later service was reestablished by making connections with the Interbrant System.

The damage is estimated at between $380,000 and $1,360,000. It is known that the bed plates of at least three of the units are cracked and that the stator windings of one generator are damaged.

Hugh Cooper Honored at Dnieprostroy Dedication

Because of its many features, the Dnieprostroy hydro-electric plant in Soviet Russia has for several years attracted attention of engineers all over the world. This plant was formally dedicated Oct. 10 by Soviet government officials and Communist leaders, as Lenin's Plant. At the dedication ceremonies Mikhail Kalinin, president of the Soviet Central Executive Committee, announced that the Order of the Red Banner of Labor had been awarded to Col. Hugh L. Cooper, consulting engineer and designer of the plant and to five other Americans who participated in the development.

Two of the nine units in the ultimate development were in operation at the dedication. Five machines are practically completed; four are yet to be installed. All equipment has been ordered, and the nine waterwheels and five of the generators have been built in the United States.

Anthracite Institute Meets At Primos, Pa.

Engineers from leading anthracite producing companies joined with the staff of the Anthracite Institute Laboratory in Primos, Pa., Oct. 21, in a conference upon advanced development work of the Laboratory in the direction of automatic consumption of anthracite in all sizes. The all-day session also discussed at length progress made by the Laboratory toward automatic ash disposal. A feature of the demonstrations was study of an automatic anthracite stoker with self-acting ash disposal, for use in office buildings and large apartment houses. The apparatus is now under development on the floor of the Laboratory.

Setting Heights for Small Boilers Subject of Meeting

The A.S.M.E. Pure Air Committee will hold a meeting in the Engineering Societies Building, Friday, Dec 9, for the purpose of fixing recommended setting heights for small boilers.

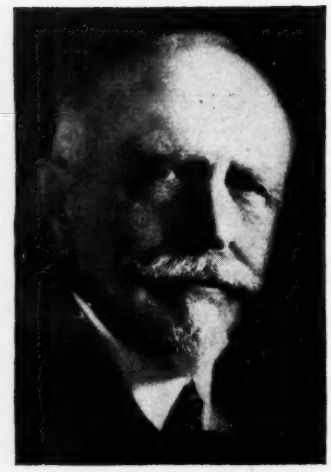
All the manufacturers' associations interested in the building of small boilers for heating and power purposes, as well as the stoker manuufacturers, have signified their intention of sending authorized delegates. It is expected that from this meeting there will result a complete clarification of the differences which have existed between manufacturers of small boilers and stokers, users and those charged with the responsibility of enforcing anti-smoke laws.

Kembs Plant in France Goes Into Operation

Oct. 9 President Lebrun and Premier Herriott of France formally opened the Kembs hydro-electric power station on the Rhine canal. This plant is one of eight that are to be erected along the canal.

It is laid out for five 36,000-hp., propeller-type turbines of the fixed-blade type to operate under a 54-ft. head. Each unit will discharge 6,800 sec.ft. of water at full gate and will operate at a speed of 94 r.p.m.

OBITUARIES



JOHN RIPLEY FREEMAN, 77, internationally known hydraulic engineer, died at his home in New York of heart trouble Oct. 6. Few American engineers were as well known internationally as Mr. Freeman, and none have had a more prominent part in the development of closer relations among enginneers throughout the world. He was hydraulic engineer and later president of several of the largest fire insurance companies where he developed the specifications now almost universally adopted for underwriters' fire pumps, nozzles, hose and the like. In addition to work on a number of important hydraulic projects, including the Panama Canal, he was consulting engineer for regulation projects on the Great Lakes, the Canadian Government's water power conservation plan, and for water power development of the St. Lawrence river. He was the leading figure in the establishment of the National Hydraulic Laboratory, a member of virtually every professional engineering society, and was president of the A.S.M.E. in 1905 and the A.S.C.E. in 1922. An honorary member of the latter since 1930, he was to be made an honorary member of the former at this year's annual meeting.

JOHN EDGAR ELDER, 58, general manager and chief engineer of the New York Stock Exchange Building Co., died in New York Oct. 16. He had been general manager of the company, which controls four buildings, since 1922, and was an important figure in both the A.S.M.E. and the N.A.P.E. He was a member of Pheonix Local No. 24 of the Power Engineers for 25 years and was its president in 1913. For the past five years he had been affiliated with Empire State Local No. 1.

TINIUS OLSEN, 86, pioneer in the development of testing machinery in the United States, oldest living member of the Franklin Institute and holder of its John Scott and Eliot Cresson medals, founder of the Tinius Olsen Testing Machinery Co., Philadelphia, and a Commander Knight of the Norwegian Order of Olaf, died in Philadelphia Oct. 20.

DR. CYPRIEN O. MALLIOUX, 72, distinguished scientist and engineer, died suddenly at his home in New York Oct. 4. Perhaps the greatest achievement of his useful career was the organization of the International Electrotechnical Commission, on which he did much of the pioneer work, of which he was president in 1909 and honorary president at the time of his death. He was also a charter member of the A.I.E.E., its president and the first editor of *Electrical World*. He was an officer in the French Legion of Honor and possessor of many other honors, both professional and scientific.

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PERSONALS

COL. GEORGE M. MORROW, Jr. has been elected president of the Goslin-Birmingham Mfg. Co., Inc., Birmingham, Ala., to succeed the late Julius Goslin. He has been vice-president for the past several years in charge of the two Birmingham plants, and before the consolidation was president of the Birmingham Foundry & Machine Co.

J. I. BANASH, consulting engineer, Chicago, has been elected president of the National Safety Council. His election was announced at the Twenty-First Annual Safety Congress & Exposition on Oct. 5, in Washington, D. C. J. E. Culliney, Bethlehem Steel Co., has been elected vice-president for engineering, and George H. Warfel, Union Pacific Railroad Co., vice-president for industrial safety.

H. H. BARNES, JR., vice-president of the General Electric Co., 120 Broadway, has accepted chairmanship of the Electrical Industries & General Machinery group of the Emergency Unemployment Relief Committee to assist in raising funds for unemployment relief this winter. This division, which is organizing 100 major trade groups, last year raised more than $10,000,000 of the $19,000,000 raised by the committee.

W. H. DRAPER, plant superintendent of the gas department, B. C. Electric Railway Co., Vancouver, B. C., has been promoted to superintendent of the gas division for Vancouver Island with jurisdiction over the gas plant at Victoria, mains, services, and new business. He succeeds Fred H. Hewlings, who has retired after 47 years of service.

J. J. DONOVAN, manager of the air-conditioning department, General Electric Co., has been elected a director of the American Oil Burner Association.

D. W. MCLENEGAN has been appointed assistant engineer of the commercial engineering division of the General Electric air-conditioning department.

C. B. GARRISON, who has been chief engineer of the Central Life Insurance Co.'s building in Cincinnati, Ohio, for twenty years, has been appointed an aid-de-camp

on the staff of Governor Ruby Laffoon of Kentucky, with the rank of Colonel. During the War, Mr. Garrison was United States fuel inspector in Northern Kentucky and was a member of the Campbell County Council of Defense. Mr. Garrison is well known in the building engineering field for his investigations of the factors that affect elevator rope life. He has been a reader of *Power* for many years and has contributed to its columns several times.

FRANK L. GIBBONS has been appointed director of steel sales of the Timken Steel & Tube Co., Canton, Ohio.

R. C. COSGROVE, manager, refrigeration division, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has been placed in charge of the company's domestic air-conditioning activities in addition to his present duties. He has been with the company since 1919.

J. E. MCFATE, formerly with Jones & Laughlin Steel Corp., has been appointed sales representative of Republic Steel Corp., Youngstown, Ohio, in the New England territory, with headquarters in Boston.

F. J. RUDD has been appointed managing engineer of the motor department, General Electric Co., according to an announcement by N. J. Darling, manager of the River Works at Lynn, Mass. He succeeds L. E. Underwood, who has been made manager of the Pittsfield, Mass., works of the company.

C. H. STEVENS spoke on "Steel Frames for Diesel Engines" before the Diesel Engine Users' Ass'n of London, England, on Oct. 12.

HERMAN ALEXANDER WAGNER, engineer of Chicago, has been awarded the second Clausen Gold Medal awarded by the American Association of Engineers for distinguished service performed in behalf of social and economic welfare work for the engineer.

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BUSINESS NOTES

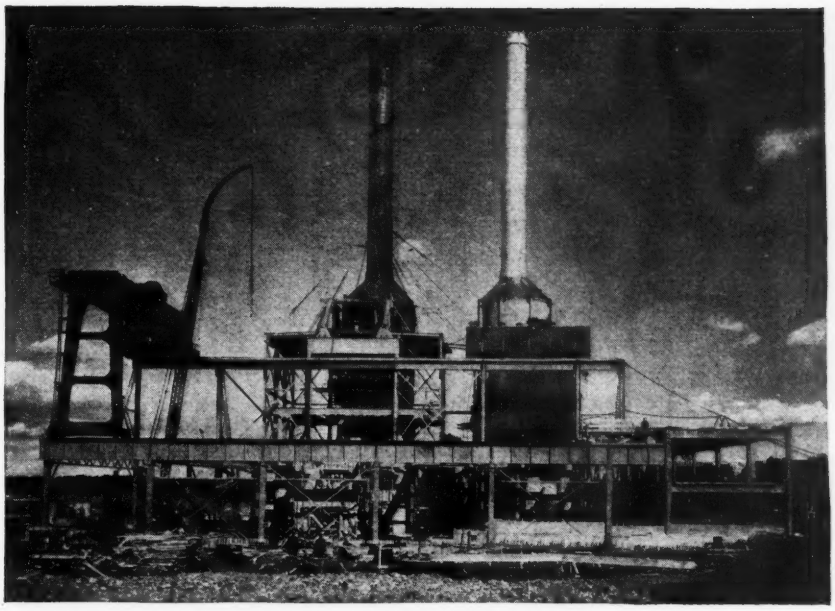
KEYSTONE LUBRICATING CO., 21st, Clearfield & Lippincott Sts., Philadelphia, Pa., whose plant was burned to the ground Oct. 3, signed a contract two days later to rebuild on the same site and on the same foundations. Operations for rebuilding will start at once and are planned in such a way that the plant will be operating while the administrative portions of the structure are still unfinished. Production will be resumed in six to eight weeks.

C. A. PEARSON, formerly eastern sales manager and manager of the New York office of General Refrigeration Co., Beloit, Wis., has become national supervisor of commercial sales for the York Ice Machinery Corp., York, Pa., with headquarters in York.

S. F. BOWSER & CO., INC., has moved its New York office to the Chrysler Bldg., 135 E. 42nd St.

UNIVERSAL VALVE & FITTINGS Co., E. 38th St., & N.Y.C.R.R., Cleveland, has been appointed agent in that district for Kieley & Mueller, Inc., 34 W. 13th St., New York, N. Y., manufacturer of pressure control devices and specialties.

D. M. ARCHER has been appointed representative of the Sarco Co. for the New England States, with offices at 11 Wolf St., West Roxbury, Boston, Mass.



Latest construction photograph of the $4,000,000 outdoor steam-generating plant of the General Electric Co. Utility and industrial plant needs will be coordinated in this mercury-vapor plant to be completed next spring.

STRAWS

Pointing the way the business wind blows

Distinct improvement in the copper and brass industry has been going on for some weeks, and officials expect the improvement to continue, subject to seasonal conditions, according to F. S. Chase, speaking before the Copper & Brass Research Association.

Allis-Chalmers Mfg. Co. has received an order for a half million dollars worth of electrical control equipment for the new Eighth Avenue subway, New York, N. Y.

Roots-Connersville-Wilbraham, Connersville, Ind., reports a substantial increase in volume of business during September. Orders booked were 43½ per cent greater than the total for July, and 26½ per cent greater than the total for August. September orders were 32 per cent better than the total for the same month in 1931.

Contracts have been let to Westinghouse Electric & Mfg. Co., Babcock & Wilcox, Mount Chemical Equipment Co., and Dorr Co., by the Bogalusa Paper Co., Bogalusa, La., for portions of the plant improvements amounting to $1,250,000 to be made at once.

Bremerton Navy Yard, on Puget Sound, Wash., is revamping its entire distribution system. One item alone is a 3,000-kw. turbo-generator.

Two 31,000-sq.ft., two-pass, Foster Wheeler surface condensers are being put in the Cabin Creek, W. Va., plant of the Appalachian Electric Power Co. One condenser will serve a 25,000-kw. G.E. turbine, and the other, a 20,000-kw. Westinghouse turbine.

Atlanta, Ga., is planning a $6,000,000 city-owned hydro-electric plant on the Chattahoochee River.

An R.F.C. authorized loan will go to Madison, S. D., for a $105,000 addition to its municipal power plant.

Activities of the Industrial Rehabilitation Committee, in the St. Louis district, have resulted in orders for $300,000 worth of machinery and equipment during the week October 10-17.

Babcock & Wilcox Co. has been awarded a contract by the Potomac Electric Power Co., Potomac Power Station, Washington, D. C., for two complete boiler units, each having a capacity of 375,000 lb. of steam per hour. The units consist of boilers, superheaters, economizers, air heaters and desuperheaters, with water-cooled slag-tap furnaces. This is the largest order for this type of equipment placed by a public utility during the past year. The turbine award went to Westinghouse.

Establishment of a steam plant for generation of electrical energy in the city of Vancouver is now being considered by the Vancouver city council. This body recently presented instructions to prepare estimates on the cost of establishing a plant, and of distributing energy to supply the city street lighting system.

Included in the project to be built with a $40,000,000 R.F.C. loan to the Los Angeles-Metropolitan Water District are a transmission line with 17 substations, six pumping plants, an 80,000-kw. hydro plant at Parker Reservoir, and several small plants along the west slope of the mountains to recover a portion of the power used in pumping.

Westinghouse Electric & Mfg. Co. has purchased 4 million pounds of copper in excess of current business demands.

With a sharp upturn in power sales, the Seattle, Wash., City Light Department reports an eight-month net income of $505,462.61. This is a gain of $52,968, or 11.7 per cent.

Williams College, Williamstown, Mass., has modernized its heating plant through the addition of two new steam generating units. Each has 4,080 sq.ft. of heating surface and consists of a bent-tube boiler fired by an underfeed stoker in a refractory and water-cooled furnace.

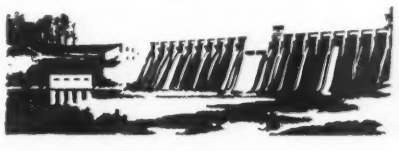
Taylor & Co., Inc., is erecting a new plant at Betzwood, Pa., to manufacture vulcanized fiber and laminated synthetic resinous products. The boiler plant will contain one 467-hp., Edge Moor, four-drum, bent-tube boiler for 448 lb. operating pressure equipped with superheater for 150-deg. superheat. There will also be an integral economizer. Diamond soot blowers will be used, and coal and ash handling equipment will be Beaumont. The stoker will be a four-retort Westinghouse, with Sturtevant forced and induced draft fans. A 500-kw. General Electric non-condensing turbine will be installed to deliver steam to process at two different pressures.

Electrically-operated pumping machinery, heavy-duty motors and controls, transformers and accessories, regulators, etc., will be installed in new additions at the Torrance, Calif., oil refining plant of General Petroleum Corp., Los Angeles, at a cost of $1,000,000.

The largest single order of electrical equipment for cableways is being shipped from the East Pittsburgh works of Westinghouse for use in construction of Hoover Dam. The shipment includes five 500-hp., 585-r.p.m. main hoist and trolley motors for the five 20-ton cableways, nine motors ranging in size from 75 to 150 hp. for moving cable towers sideways, and 33 control boards.

Secretary Chapin, of the Department of Commerce, recently pointed out to a group of business paper editors that the United States Patent Office has caught up with all its work. Inventors need not worry about the long delays so prevalent in the past. Principal activity tends toward classifications in electrical and electronics, road machinery, automobile refrigeration and air conditioning, and applications of ball and roller bearings for railroad use.

Extension of time was recently granted by the British Columbia Provincial Water Board to the Westminster Power Co., Ltd., Vancouver, B. C., a subsidiary organization of the B. C. Electric Railway Co. The company applied for water rights in connection with the diversion and use of waters from the Meslilote River in 1913. Since then it has been granted a number of extensions. The latest amendment obligates the company to spend $150,000 on the project by the end of 1935 and $500,000 by the end of 1936. Under the terms of the extension a total investment of one million dollars must be shown by 1938.



New Bulletins

CENTRIFUGAL PUMPS—De Laval Steam Turbine Co., Trenton, N. J., has issued a catalog "De Laval Single-Stage Double-Suction Pumps" under No. B-4, which describes this company's centrifugal pumps for large outputs. Included among the pumps illustrated are geared turbine-driven pumps delivering 75,000,000 gal. per day against 150 ft. head, and motor-driven pumps of 30,000,000 gal. per day capacity against 250 ft. head.

TURBINE BLOWERS—L. J. Wing Mfg. Co., 154 W. 14th St., New York, N. Y., has issued Bulletin T-97 describing "Wing" turbine blowers, including data, photographs and engineering information regarding the use of "Wing" blowers for forced draft service with hand-fired, stokered and oil-fired boilers.

WELDING RESEARCH—American Welding Society, 33 W. 39th St., New York, N. Y., has issued a bulletin, "A List of Fundamental Research Problems in Welding," compiled by the American Bureau of Welding.

CONTROL VALVES FOR WATER WORKS—Baldwin-Southwark Corp., Philadelphia, Pa., has issued Bulletin No. 35 on "Automatic Control Valves for Water Works Service," describing slow-closing check valves, altitude valves and pressure regulators operating on the Larner-Johnson principle, and also a surge suppressor described in *Power* in September.

TEMPERATURE MEASUREMENTS—Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa., has issued Bulletin No. 871 on "Temperature Measurements in Generators, Transformers and Cable Systems," describing the instruments the company manufactures for this service.

UNIT-TYPE DESIGNATORS — Delta-Star Electric Co., 2400 Fulton St., Chicago, Ill., has issued Price List No. 63 covering unit-type designators for making up signs for attaching to operating handles of gang-operated switches, designating circuits, for cell identification, oil switch and transformer numbering, and operating and construction signs.

VARIABLE-SPEED TRANSMISSION—Waterbury Tool Co., Waterbury, Conn., has issued Bulletin No. 121 on "Waterbury Hydraulic Variable-Speed Transmission and Variable Stroke Pumps" for various power plant services.

OVERHEAD HANDLING — Whiting Corp., Harvey, Ill., has issued Book No. 214 on cranes, including 68 pages of pictures and descriptive matter showing the company's complete line of electric and hand-powered traveling cranes.

BOILER WATER LEVEL GAGES—Dobbie McInnes & Clyde, Ltd., 57 Bothwell St., Glasgow, C.2, Scotland, has issued a circular on "Dobbie-McInnes" remote reading boiler water level gages.

LEFAX DATA—Lefax Foundation, Philadelphia, Pa., has issued the following new inserts for handbooks: "Coordinated Laws of Concrete Mixtures and Their Application"; "Strength of Materials"; "Specific Gravities and Weights of Materials"; "Graphical Representation of Engineering Equations"; "Western Red Cedar Poles."

CONCRETE STRUCTURES—The Engineering Extension Department of Purdue University, Lafayette, Ind., has issued Extension Series No. 27, "How to Avoid Faulty Concrete in Small Structures," describing a series of experiments at the University on this subject.

SHAFT VIBRATION—A "Bibliography of the Vibration of Shafts, Vibration Measurements, and the Design of Crankshafts," by A. C. Bates and M. J. Zucrow, has been issued by the Engineering Experiment Station of Purdue University, Lafayette, Ind., as Research Series No. 39.

HAND-OPERATED STARTING SWITCHES—Allen-Bradley Co., Milwaukee, Wis., has issued a leaflet on Bulletin 609 hand-operated starting switches.

BOOSTER COMPRESSORS—York Ice Machinery Corp., York, Pa., has issued Bulletin No. 32164 on "York Booster Compressors," including the semi-inclosed, vertical and single-acting types.

PIPE SPECIALTIES—Sarco Co., 183 Madison Ave. New York, N. Y., has issued a folder on Sarco Pipe Savers, describing steam traps, temperature regulators, self-cleaning strainers and similar specialties.

New Plant Construction

Alabama—Bids Nov. 15, by U. S. Eng., Volunteer Bldg., Chattanooga, Tenn., 360 ft. dam, 60 ft. wide, lock 37 ft. lift, in Tennessee River, above Wilson Dam, below Chattanooga, Tenn., hydro electric.

Calif., Alameda—Burns, McDonald & Smith, engrs., 1031 South Bway., Los Angeles, will make srvey for city to determine if municipal lighting and power plant should continue to purchase electricity or operate its own generating plant. Site for plant is available.

Calif., Escondido—City plans electrical system, Diesel power plant and distribution system. Condemnation proceedings will be started against San Diego Consolidated Gas & Electric Co., to acquire that company's system.

Calif., Fresno—C. E. Butner, archt., Cory Bldg., taking bids 1 story, 35 x 100 ft., brick, Blackstone Ave., for Fresno-Madera Ice Co., Blackstone Ave.

Calif., Huntington Park—Coast Packing Co., plans by J. C. Barr, 2069 Randolph St. 73 x 94 ft., rein.-con. addition, incl. cooler and freezer rooms.

Calif., Oakland—F. H. Morgan, et al c/o W. H. Weeks, archt., 525 Market St., San Francisco, 1 story, basement, brick market, incl. housing 30 food concessions refrigerating plant, etc., Franklin St. $115,000.

Calif., San Bruno—City preparing plans outfall sewer and pumping plant in Third addition and Lomita Park. $18,000. R. Klassen, city engr.

Colo., Greeley—Teachers College, plans heating plant. $84,000.

Conn., New Haven—City, Engineering Dpt., City Hall, plans complete heating plant for City Hall. $25,000. E. Nettleton, City Hall, engr.

Fla., Pahokee—City plans election to cover cost of water system, incl. piping, pumping and treating plant, elevated tank. L. L. Stuckey, mayor. C. B. Rafhn, Clewiston, engr.

Ill., Wilmette—Bids Nov. 15, by N. P. Miller, village clk. for Pres. and Bd. Village Trustees, Village Hall, waterworks structures, piping and filter equipment, pumping equipment, electrical work, engine generator, intake and connecting main on lake shore, foot Lake Ave., in Wilmette and in Lake Michigan, Pearse, Greeley & Hansen, 6 North Michigan Ave., Chicago, Ill., engrs.

Ind., Mitchell—City Council taking plans remodeling pumping station at Waterworks Plant, and constructing new sediment basin, $16,000. C. H. Hurd, 306 Lumber Insurance Bldg., Indianapolis, engr.

Iowa, Corning—City, V. J. Mack, Clk., plans election to vote on proposition to build light and power plant. $160,000.

Ky., Riceland—Municipality plans waterworks pumping and water supply equipment. To exceed $17,000.

Miss., Greenwood—City, W. K. Clements, mayor, flood protection improvements to raise levee system 1 ft. above crest of 1932 floodwaters and installing pump for surface waters in all sections of city. Preliminary surveys under way. City will probably seek loan from Reconstruction Finance Corp.

Miss., Poplarville—Municipality plans electric light and power plant and pumping plant for waterworks system. $100,000. V. B. Smith, Jr., Gulfport, engr.

Mo., Washington—City plans municipal power plant. $400,000. Burns, McDonnell Eng. Co., 400 Interstate Bldg., Kansas City, engrs.

N. Y., Mentz—Empire Gas & Electric Co., Geneva, granted franchise electric plant.

N. Y., New York — Merchants Refrigeration Co., 17 Varick St., plans by J. J. Snook Sons, 299 Bway., altering 10 story storage, loft and store, 501 West 16th St. $200,000.

N. Y., Savannah—Empire Gas & Electric Co., Geneva, electric plant and distribution system. $40,000.

N. Y., Watson—Northern New York Utilities Co., 58 Publis q., Watertown, extending distribution system and electric plant, day labor and separate contracts. $25,000. Public Serv. Comn. granted permit.

N. C., High Point—City, E. M. Knox, city mgr., considering making application to Reconstruction Finance Corp., for loan for municipal power plant. $1,080,000.

Okla., Oklahoma City—Evans Milk Co., 1400 North Eastern Ave., plans by Shumacker & Winkler, 1st Natl. Bank Bldg., 2 story, basement, 85 x 150 ft., ice cream and cold storage plant on 22nd St. $50,000.

O., Cuyahoga Falls—City, G. D. Porter, mayor, soon lets contract 1 story, 57 x 100 ft., brick, steel municipal power plant. $25,000. N. C. Bell, City Hall, engr. and archt.

O., Galion—City surveys by Hadlow, Hughes, Hick & Conrad, archts. and engrs., Citizens Bldg., Clevelnad, additions to municipal light plant, incl. replacing equipment. $200,000.

O., Oberlin—City, L. A. Sears, mgr., election Nov. 8, $250,000, brick, steel, concrete municipal light plant. R. Husselman, Hippodrome Bldg., Cleveland, engr.

O., Youngstown — M. Moore, mayor and A. Ingersoll, dir., utilities are obtaining data on building a municipal power plant. Project in very formative state.

Pa., Lancaster—Bids Nov. 21, sewage treatment plant, inc. 2 sewage pumping stations. J. N. Chester Engineers, 717 Liberty Ave., Pittsburgh, Pa., engrs.

S. D., Madison—City plans power and light plant addition. $105,000. Loan granted by Reconstruction Finance Corp.

Tex., Goose Creek—City, c/o Secretary, voted $350,000, light and power plant.

Va., East Radford — State of Virginia authorized Appalachian Power Co., Richmond, to construct, operate and maintain hydro-electric power plant on New River, near here. $12,000,000.

Va., Lexington—City, F. A. Dunn, chn. Waterworks Com., new waterworks. $200,000. R. B. Barrie, city engr.

Va., Tazewell—Jewell Ridge Coal Corp., plans hydro-electric power plant, with dam on Dismal River, Buchanan Co. $125.000.

Wis., Columbus—City making plans water softening plant, incl. mixing basin, clarifier tank, carbonating basin, incl. 2 filter units, pumps, etc. $25,000. W. F. Reichardt, city engr. Alvord, Burdick & Howson, 20 North Wacker Dr., Chicago, Ill., consult. engrs.

Wis., Rhinelander — City, T. M. Wardwell, mgr., making surveys electric light plant. Engineer not appointed.

B. C., Vancouver—City Council to have report prepared by C. Brackenridge, city engineer, and C. H. Fletcher, city electrician, for construction steam plant for generating electricity.

Ont., Almonte — Town Council considering plans for second unit of power plant. $16,000.

Latvia, Riga — Government, hydro-electric power station across Duna River, to Foundation Co., 120 Liberty St., New York. Est. $5,000,000.

Equipment Wanted

TURBINE GENERATOR, etc.—**Los Angeles, Calif.**—T. Augton, city purch. agt., City Hall, rescinded bid call to have been opened Aug. 23, steam turbine electric generating unit, Spec. 2827. Will readvertise.

PUMPS and PUMPING—**Alexandria, La.**—Bids Nov. 3, by Bd. Comn. Red River Atchaf. and Bayou Boeuf Levee Dist., State Bd., furnishing 2 electrically driven pumps must be able to deliver each 50,000 g.p.m. against head 16 ft., and installing concrete, hollow tile pumping plant, concrete found. on landward end of Bayou Rapides Culvert, Rapides Parish.

POWER EQUIPMENT — **Phila., Pa.** — Dpt. City Transit, C. C. Davis, dir., City Hall Annex, plans to purchase equipment for South Broad St. Subway, incl. tracks, powerfeed rail, signal system, station equipment, new power substation, electric wiring, etc. $1,600,000.

PUMPING UNIT—**El Paso, Tex.**—City, G. B. Davis, taking bids pumping unit for waterworks, incl. booster pumps, double suction, centrifugal pump, 1,700 r.p.m. 50 ft. head, 4,000 g.p.m.

POWER EQUIPMENT — **Grahamstown, South Africa** — City Clerk will receive bids Nov. 8 by cable or otherwise, supply steam raising plant, incl. supplying and erecting new power station of 1 watertube boiler with integral superheater mechanical stoker, soot blowers and all accessories; also in market for 1 Green's Economizer with 280 tubes; 1 induced draft draught plant and steel chimney; steam and feed ranged with pumps; ash elevator and hoist; three 1,000 kva. transformers; 500 kva. transformer 11,000/3,300; 2 transformers 150 kva.; one 250 kva. transformer 11,000/416/240 v. and 2 turbo alternators, 1,200 kva. all complete with accessories.